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Advances in tree form of citrus, apple and grape

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Abstract
By referring to the literature and combining with the production practice, the significance, development process and main application in the study of the three common fruit tree shapes of citrus, apple and grape in recent years were studied, and the relationship between the different tree shapes of the three fruit trees and fruit yield and fruit quality was summarized, in order to promote the rationalization of the application and practice of fruit tree shapes, and to provide reference for the scientific research workers and producers.

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1. Introduction

Tree shape refers to the spatial structure of trees in natural growth or artificial cultivation. In fruit cultivation, various tree shapes can be derived according to the different characteristics of fruit trees and orchard environment. The tree shape of fruit trees directly determines the canopy structure and micro-domain environment of the tree crown, affects the light distribution of each part of the tree crown, and thus affects the photosynthesis of fruit trees, which has an important impact on the yield and quality of fruit trees and the determination of cultivation and management measures [1-2]. Citrus, apple and grape are typical representatives of evergreen fruit trees, deciduous fruit trees and vine fruit trees, which occupy an important position in the fruit industry in China. In this paper, we summarized the research situation of the tree shape of these three kinds of fruit trees, and analyzed the influence of different tree shape on the photosynthesis, fruit yield and fruit quality of these three kinds of fruit trees.

2. The common tree form of oranges, apples, and grapes

Natural growth state, dry strong citrus will grow into natural round head shape and cylindrical shape, dry weak citrus will form multiple trunk cluster shape. In cultivation, citrus trees can be divided into two types of trees with and without a central trunk. The tree with a central trunk mainly has trunk shape, variable trunk shape and spindle shape, while the tree without a central trunk mainly has happy type and natural open-heart shape [3]. Trunk shape is characterized by tall crown and natural stratification. The main trunk shape is characterized by tall crown, large effective volume, uniform distribution of main branches, reasonable density, good ventilation and light transmittance, and high yield. Spindle shape has the characteristics of good stable yield shape and uniform bearing parts. Heart-shaped and natural heart-shaped trees open the peace exhibition.

At present, the main cultivation mode of apple is dwarf dense planting, and its tree shape is mainly spindle shape [4]. The tree shape of dense planting mode is mainly spindle shape, which can be divided into free spindle shape, slender spindle shape and high spindle shape according to planting density. Free spindle shape is suitable for medium dense planting mode (55-83 plants /667.7m2), and has the characteristics of simple structure, fast forming, easy pruning, ventilation and light transmission, early fruiting, and easy management [5]. Slender spindle shape is suitable for high density planting mode (83-111 plants /667.7m2), which has the advantages of early bearing, high yield, easy mechanization, and saving labor, water and fertilizer [6].

The common tree shapes of grapes are fan shaped, dragon stem shaped and factory shaped. Multi-main vine fan is the most commonly used tree shape of wine grapes in China, which has the advantages of flexible pruning and easy adjustment of bud load [7]. The shape of Longgan is suitable for trellis cultivation. According to the number of longgan, it can be divided into only longgan, double longgan and multiple longgan. Dragon stem is evenly distributed on the shelf surface, and each dragon stem bears many fruiting branches, which are characterized by obvious apex dominance, vigorous extraction of upper branches and good differentiation of flower buds, while thin lower branches, resulting in upward movement of bearing parts and obvious disjointed emptying [8].

3. Effect of tree shape on photosynthesis in fruit trees

3.1 Effect of tree shape on photosynthesis of citrus

There are also differences in the appropriate tree shape between citrus types and varieties. Some scholars compared the photosynthetic parameters of different tree shapes of Wenzhou Tangerine, and found that the net photosynthetic rate, transpiration rate and stomatal conductance of leaves in open heart shape in summer were significantly higher than those of natural round head shape, and the intercellular CO_2 concentration was significantly lower than that of natural round head shape [9]. After Hu Deyu transformed the closed navel orange tree shape into open heart shape, hedge shape and trunk shape, the content of chlorophyll a, chlorophyll b and total chlorophyll increased significantly [10].

3.2 Effect of tree shape on photosynthesis in apple

Different tree shapes first affect the light distribution of the tree body, and an appropriate tree shape can ensure the evenness of the light in the crown. Guo *et al*. [11] made a comparative analysis of the light distribution and utilization of four different tree shapes of golden red apple, and found that the light intensity in the crown of sparse layer, naturally open heart and free spindle shape of small crown was higher than that of open layer shape. In red Fuji apple, it was found that light intensity in the outer, middle and inner layers of high-stem open-heart crown was significantly higher than that of sparse and spindle-shaped small-crown trees [7].

3.3 Effect of tree shape on photosynthesis of grape

The classification structure, spatial layout, leaf curtain density and load ratio of aboveground parts of grape plants with different tree shapes were significantly different [12]. Jiang Li compared the photosynthetic parameters of "Yi" shape grape leaves with high-stem inverted umbrella shape, and found that the chlorophyll content of "Yi" shape grape leaves was significantly higher than that of high-stem inverted umbrella shape grape leaves, and the actual photochemical quantum yield, electron transfer efficiency and photochemical quenching coefficient of "Yi" shape grape leaves were significantly higher than those of high-stem inverted umbrella shape grape leaves [13].

4. Effect of tree shape on fruit quality and yield of fruit trees

4.1 Effects of tree shape on citrus fruit quality and yield

The results showed that the contents of soluble solid in the inner chamber and the southeast side of the main stem of Wenzhou Miquat with open-heart shape were significantly higher than those in open-heart shape. The fruit shape index of the open heart layer is significantly higher than that of the natural round head shape [9]. The yield per plant of Powell Navel orange with different tree shapes was in the order of open heart > trunk > hedge > natural round head from high to low [10].

4.2 Effect of tree shape on apple fruit quality and yield

In the experiment of Gao *et al*.[14] physiological indexes of plants with three different apple tree shapes were measured, and it was found that single fruit weight, fruit shape index, soluble solid, anthocyanin content and coloring of high-stem open-heart apple tree fruits were significantly higher than those of small-crown sparse layer and spindle shape.

4.3 Effect of tree shape on grape fruit yield and quality

In the study of "Jufeng" grapes, it was found that the soluble solids and sugar-acid ratios of "Yi" shaped grapes were significantly higher than those of high-stem inverted umbrella shape, and titratable acids were significantly lower than those of high-stem inverted umbrella shape [13]. At the same time, the influence of tree shape on grape fruit quality is also closely related to grape varieties. Factory shaped tree shape is conducive to the accumulation of glucose, fructose and sucrose in Cabernet Sauvignon, while fan-shaped tree shape is conducive to the accumulation of glucose in Chardonnay fruits [15].

5. Research prospect and prospect

Fruit tree shape is an important factor affecting plant growth and fruit quality. It is of great significance to select suitable tree shape to improve fruit yield and fruit quality. With the increase of labor cost and mechanization of orchard, the research of fruit tree shape is also changing gradually. The traditional tree management requires a lot of manual trimming, which is no longer suitable for the current trend of orchard development. It is imperative to develop a tree suitable for light simplification and mechanization management. At the same time, various tree shaping processes break the balance between vegetative growth and reproductive growth of fruit trees in the state of natural growth, and improve the yield and fruit quality of fruit trees by inhibiting vegetative growth and promoting reproductive growth. However, the internal physiological and molecular biological mechanisms are unclear and need to be further studied and explored.

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