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Research Paper

Maturation of shoots, leaves and fruits of Ecolly grape in response to alternative new pruning system and harvesting times in China

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ABSTRACT

This study investigated effect of two trellises, single crawled cordon training (SCCT) and independent long-stem pruning (ILSP) on change of total organic carbons (TOCs) in the shoots and leaves and microstructure of shoots in early October, as well as total soluble solid (TSS), total acid (TA) and maturity index (MI) of 'Ecolly' grape on July 21, 29 and August 24, respectively. The results proved that there was obvious difference from TOC between shoots and foliage of the two trellises. TOC level of shoots in the first, second, third and fourth, except for the fifth, from the root of the main stem labelled in ILSP was higher than those in SCCT, respectively. Level of blades followed the former. The maturity level in SCCT shoots and blades was superior to ILSP, despite total value, 3261.64 g/Kg, of TOC accumulated in ILSP shoots and leaves exceeded those, 2955.37 g/Kg, in SCCT, respectively, whcih could be observed through microstructure in various trellises of shoots. Additionally, identical TSS per shoot in SCCT was higher than that in ILSP during three consecutive seasons excluding the second and third shoots on August 24. Although SCCT revealed higher TSS than ILSP before August 9, and other results (concurrent 16.8% and 17.2%, respectively) between August 9 and 24, there were still no significant variety between trellises after August 24, MI was similar. Meanwhile, SCCT (4.54 g/L in 26 August and 3.82 g/L in 11 September) had higher TA than ILSP (4.23 g/L in 26 August and 3.62 g/L in 11 September) except before August 24. Therefore, SCCT could be proposed as a viable choice improving ripening process, quality of grape and maturation of shoots and leaves for China growers.

1. Introduction

The optimal ripening time and maturity level had the strongest influences on improving potential quality of grapes and wines. Recent studies had investigated the corporate roles of sugars, acids, pigments, tannins and aromatic compounds in grapes on determining the optimal ripeness and quality of the grapes and wines ultimately (Iland and Coombe, 1988; Peña-Neira et al., 2007).

Effect of total sugar was vital to quality of grape, which contained not only on biochemical function but also on accumulation of phenolic and anthocyanin compounds of berries during the growth (Sánchez-Palomo et al., 2005; Kashif et al., 2011). High sugar contents of grape were also contributed to wine's rich, complex and elegant flavors. Organic acids, consisted mainly as malic acid, tartaric acid and citric acid in grape, were very rich as essential and main compositions in must and wine. PH, related closely to acid content, was a critical determinant of wine quality and the main contributor to wine stability during the aging period. A high pH often resulted in unstable musts and wines that were more susceptible to oxidation and microbiological spoilage, and also a decrease of color in red wines as a result of reduced anthocyanins ionisation. These wines had generally lower acidity and a flat taste (Mpelasoka et al., 2003). Traditionally volatile quality was contributed to grape maturity corresponding to an optimal sugar/acid ratio, which mainly depended on the grape variety, cultural practices, d climatic or biological factors (Li et al., 2010; Nan et al., 2013).

In recent years, many studies had been carried out to identify

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potential of grape viticultural region related to a distinct quality of grapes and wines. Maintaining the most cost-effective balance between vegetative and reproductive growth was one of the most significant problems in recent years. The valuable compositions in grapes were synthesized during the berry maturation, and qualitatively and quantitatively influenced by a number of indexes, such as grape variety, soil, climate and viticulture practices. However, the manipulations of the vines, such as the optimization of the shoot density (Terry and Kurtural, 2011), the increase in the grapevine spacing (Heuvel et al., 2013), divided canopy and basal leaf removal (Scheiner et al., 2010) to achieve grapevine balance, were primarily responsible for controlling shoot growth while maintaining crop yield and improving fruit quality. Accumulation of total sugar and reduction of TA in grape berry were related to temperature and sunlight (Peña-Neira et al., 2007). Under the hot climates, the direct sunlight to the cluster had been able to contribute to excessive degradation of organic acids or flavor precursors causing negative influence to wine quality (Hall et al., 2011). The widely accepted concept was that the canopy structure management of different trellising systems affected not only the sunlight interception and carbon assimilation but also the microclimate and physiological features in the fruit zone, which had a vital impact on berry composition and wine attribute (Reynolds et al., 2004), and the benefit of the divided canopy profile in the energetic vineyard through some strategies like shoot-positioned training systems could be a valuable tool to stimulate the light microclimate of the corresponding foliage and clusters at the cluster zone(Reynolds et al., 2004) as well as affect physiological features (Basile et al., 2011), increase the foliage photosynthesis, yield and aroma concentration in grape and wine (Nan et al., 2013). Therefore, effect of various trellises on grape quality analyzed could be very useful to vineyard managements.

Sequestration function of carbon in grapevine was an important part of carbon cycle in the ecosystem of the fruit trees. Actually, different trellises could adjust the microenvironment of the grape growth, improve the light environments and temperature conditions in the cluster zone, which was advantageous to adjust the fixation role of the carbon among the shoots, leaves and fruits, improve the grape quality and even obtain high quality wines finally. These could been seen through microstructure in shoot phloem of various trellises.

Ecolly (*Vitis vinifera* L.) was a novel and also important wine grape cultivar in China but potentially difficult to manage due to its excessive vigor. Vigorous grapevines required more labor for canopy management and tend to created excess shade, therefore, the fruit quality was decreased to some extent. Treatments involving dormant pruning level, canopy-trimming and leaf removal affected the overall canopy strata density and the subsequent degree of the shade conditions in the fruit zone. Although previous investigations had investigated prominent aroma compounds of young wines from Ecolly affected by trellises (Nan et al., 2013), little was known about the variation of the physicochemical characteristic parameters induced by different trellises, especially SCCT, under consistent and long-term observation. Thus, our experiment was designed to investigate the seasonal modification of the distribution characteristics and dynamic law of the carbon the in leaves and shoots, and the physicochemical parameters of the berries by SCCT and ILSP (Nan et al., 2013) in Ecolly, as well as verify the difference by the ultrastructure of the shoot phloem for the different trellises, and provide a theoretical basis for the regionalization and field management of the high-quality grapevine. This knowledge would also enable viticulturists with a useful tool to identify zones within the vineyard of the differential grape composition to be devoted to differential wine styles.

2. Materials and methods

2.1. Experimental vineyard and layout

2.1.1. Experimental site

The vineyard, established in 2009 with wine grape Ecolly (*Vitis vinifera* L.), was located at the Chateau Heyang of 100 m^2 (Heyang grape experiment and demonstration stations of Northwest A&F University, Heyang County, Shaanxi Province, China, longitude 109° W; latitude 34° N; 780 m above sea level).

2.1.2. Agronomical characteristics of cultivar

Ecolly, eventually selected after 15 years, was a new grape cross variety breeded using 3 varieties of *Vitis Vinifera* and 2 hybrids (Chenin Blanc × (Chardonnay × Riesling)) × (pollen mixture of Chenin Blanc, Chardonnay and Riesling) as parents by Eurasian intraspecific turns selecting method, which was approved by the Shaanxi provincial crop variety approval committee on 2, 1998. There was strong resistance characteristics to disease, especially Plasmopara viticola, besides the high quality, high yield and cold resistance donated from parents (Li et al., 2000). Ecolly was transplanted by nourishing – bag seedling under the suitable mixed substrate of humus soll, perlite, soil, and dung with a proportion of 1: 1: 1: 0.3 in 2009 (Li et al., 2011).

2.1.3. Enological characteristics of cultivar

Ecolly, superior berry quality with high sugar content, moderate acidity and steady repining quality in different years, had premium manifestation of vinification characteristics for the white wine, including straw and clarity of fruit and floral aroma, and even mellow, round and well-balanced style, which promoted not only lower yield of total phenol, but also much higher level of volatile ester and amino acid (Liu et al., 2000).

2.1.4. Pruning treatments

According to the method of Nan et al. (2013) with some modification. The grapevines were trained to two different trellises – SCCT and ILSP (Figs. 1 and 2, 5 rows per trellis). Vines spacing was 3.0 m × 0.5 m, and rows were orientated north-south. In SCCT, Every grapevine was trained to one vertical shoot during the growth in the first year and developed the cordon further and pruned to five one – node spur in the late October in the same year. The next year, all vines planted were pruned to one cordon paralleling to the ground and five shoots per cordon. The vines of the third year were pruned according to the method of the second year (Fig. 1). While in ILSP, there was an acclivitous stem extending to the first wire situated at 50 cm from the ground and continued to elongate horizontally and keep the five shoots trained to the "V" type trellis above the wire during the growth period (Fig. 2). The other follows the method of SCCT. And other practices followed normal procedures in the area.

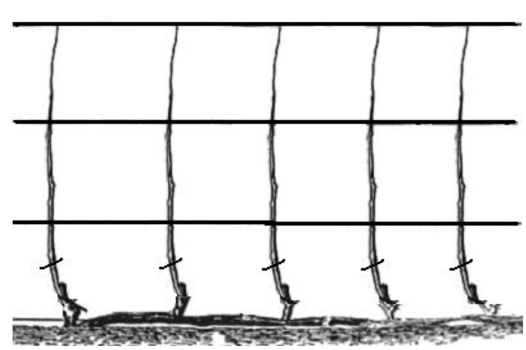

Fig. 1. Diagram of SCCT.