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A Review on Grape Growing in Tropical Regions

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Abstract

Although grapevine is adapted to a wide range of climates; the best growing of grapevine are performed in regions, which meet certain specific climatic requirements. Grape growing is also extensively carried out in the latitudes between the Tropics of Cancer and Capricorn called as tropical regions. Recent times, viticulture activities has increased significantly in the tropical regions and qualified table grapes, wine, grape juice and raisin are obtained from countries such as Brazil, Venezuela, India and Thailand located in tropical and subtropical regions. The production technics used for grape growing in tropical regions is different than used for traditional temperate regions. Most of grapes grown in these regions carry table, raisin and wine grape characteristic. Grape varieties grown in tropical regions should have early ripening periods, short growing cycles and high resistance to fungal diseases.

Keywords: *V. vinifera* L., hot climate, tropical regions, viticulture zones, grape growing

Introduction

Viticulture is performed in distinct climate regimes worldwide that provide optimum situations to produce high quality grapes (de Blij, 1983). Most of the world's viticulture regions are located between latitudes of 40° and 50°N in northern hemisphere and between latitudes of 30° and 40°S in the southern hemisphere called as temperate climatic belt (Iland et al., 2009).

There has recently been much interest in tropical viticulture and grape growing in tropical regions has been performed commercially since approximately 50 years (Jogaiah et al., 2013). There are numerous grape growing regions between the tropic of Capricorn and the tropic of Cancer, intertropical zone.

The tropic of Cancer and the tropic of Capricorn refers to that part of the earth that lays between 23° north and south latitudes. The Tropic of Cancer is located at 23° north of the equator and runs through Mexico, the Bahamas, Egypt, Saudi Arabia, India, and southern China. The Tropic of Capricorn lies at 23° south of the equator and runs through Australia, Chile, southern Brazil and northern South Africa. Among the countries with tropical climatic conditions, it can be seen that Brazil, India, Thailand and Venezuela play an important roles in the tropical grape production in the world extends in various countries of different continents in Bolivia, Colombia, Peru, Guatemala (in South America), in Madagascar, Namibia, Tanzania (in Africa) and in Vietnam, China (in Asia) (Jogaiah et al., 2013).

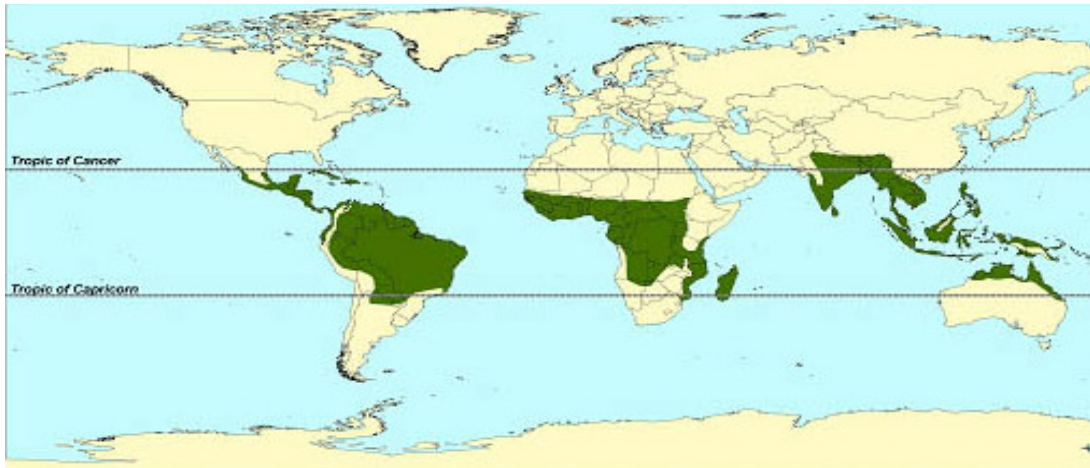


Figure 1. The tropical regions of the world

The tropics are an area of land and sea mass in world surrounding the equator and are generally defined by tropic of Cancer to the north and the tropic of Capricorn to the south (Figure 1). In tropic regions, the sun reaches a point directly overhead at least once in the course of the solar year and these regions are hotter, because they are closer to the sun. In addition to this, axial tilt of earth means a much greater variation in the sun's axis relative to the earth leading to the extreme variation between where the sun rises and sets throughout the year. So, both facts will affect grape growing and also grape quality (Commins et al., 2012). Moreover, subtropical regions are the climatic regions typically found adjacent to the tropics, usually between 23° and 40° latitude in both hemispheres. In subtropical climate, hot season duration is longer and cold season is milder and rainy.

In tropical regions, the most part of vineyards is for table grape production, but there are also increasing vineyard areas for growing of quality wine grapes (Tonietto and Pereira, 2012).

Camargo et al. (2006) notify that grape growing was introduced in Brazil in the course of the colonial period, in the 16th century and has become a commercial activity in the temperate climate regions in the south of the country only in the 20th century.

General adaptation problems of the traditional *Vitis vinefera* varieties (in terms of bud dormancy, apical dominance, low fertility, susceptibility to fungal diseases) and of the *Vitis labrusca* varieties (in terms of dormancy, lack of vigor) restrict the production to a decreased number of varieties. In order to develop new varieties that combine the attributes of

adaptation, productivity, resistance to diseases and quality of grapes, it was utilized from *Vitis vinifera* and *Vitis labrusca* varieties, interspecific hybrids and wild tropical species as the main germplasm in the crossing program (Camargo, 2000).

Traditional wine growing areas are located in temperate climate zones and allow to produce grapes only once per year. Tropical wines have been elaborated in India, Thailand, Venezuela and Brazil. For example, northeast region of Brazil makes wine production and grapevines of this region can produce two or three crops per year depending on cycle of different grape varieties.

Pereira et al. (2010) determined the physic-chemical and aromatic characteristics of some tropical wines elaborated in Northeast of Brazil with grapes harvested in November 2008.

Possingham (2004) inform that the grape is probably the most broadly grown temperate fruit crop in the tropics and subtropics with a total world production of over 3 million tonnes. India with a production of over one million tonnes is primary world producer and Brazil follows it producing less than one million tonnes in tropics. Other tropical grape grower countries are respectively, Yemen (163.000 t), Peru (136.000 t), Thailand (40.000 t), Colombia (19.000 t), Tanzania (14.000 t) and Venezuela (11.500 t).

In the tropic and subtropic climates, variations in rainfall, temperature and altitude lead to massive environmental diversity. In wet humid tropics, grapevines are evergreen, grow continuously and it is possible to have one cropping cycle per year with controlled pruning. On the other hand, grapevines have usually two

cycles per year or three cycles per two year in the dry tropics and subtropical regions (Possingham, 2004).

Carbonneau (2010) point out that the main challenges of tropical viticulture are improvement of the basic knowledge on the adaptation to tropical climates and to their constraints, the experimentation of new cultivation systems, the socio-economical pressure of those regions. The main technical challenges for a quality tropical viticulture are respectively; 1)controlling vigor that is generally excessive, 2)controlling microclimate and architecture, 3)controlling water and minerals management, 4)controlling harvest date, 5)controlling sanitary status especially under wet tropical and subtropical zones.

Grape growing in hot climate regions is different from that placed in temperate zones where grapevines have only one harvest a year.

The aim of present review is to represent differences of grape growing between tropical climate belt and temperate climate belt.

Some Characteristics of Tropical Regions

Climate

Vitis vinifera L. is a temperate climate species and main areas of viticulture are situated between the latitudes of 30°N and 50°N and between 30°S and 40°S, which approximate to 10 °C and 20 °C isotherms. Towards the equator the limiting factors to grape growing are the extreme heat, inadequate winter chilling and lack of water (Mullins et al., 1992).

In tropical climate, wide range of temperatures can be observed and climatic characteristics of tropical regions are generally summarized in Table 1 below (Düring, 2014);

Table 1. Vegetation and climatic characteristics in tropical regions

Region	Vegetation	Precipitation	Temperature
Inner tropics	Evergreen, rain forest	More than 1500 mm, even spread	Frost free, more than 25°C, difference between day and night: 0-6°C
Outer tropics	Savanna	Less than 1500 mm, dry season, wet season	High difference between day and night

Precipitation

Precipitation situation finds out annual rhythm of grapevine growth, dormancy and date of harvest.

High temperature

High temperature observed in tropical conditions has different effects on grapevine and organs of grapevine. It accelerates growth and development of grapevines, hastens first harvest time (18 months after planting), enhances grape development and must and wine quality, allows 2-3 harvest per a year, increases high evapotranspiration leading to high water demand, decreases lack of cool stimulus, leading to irregular bud breaking.

Photosynthetically active radiation (PAR)

Photosynthetically active radiation is the amount of light available for photosynthesis that is light in the 400 to 700 nm wavelength range. It can vary according to season, latitude and time of day. In tropical regions, Dormancy is not induced and the apical

photosynthetically active radiation values can reaches 2000-2200 $\mu\text{molm}^{-2}\text{s}^{-1}$.

Day length

It can be observed that day length is 12 hour light per day for equator and 8-12 hour light per day for short day.

Wind

Prevailing winds are important for grapevine and permanent winds have decreasing effects in grapevine growth and crop yield in coastal areas.

Annual Rhythm of Growth and Dormancy

buds burst shortly after the topping or pruning of the shoots (Table 2). The apical dominance is expressed in rapidity of bud bursting. Grapevine doesn't undergo a vegetative dormancy in tropical climate regions and if adequate nutrition and water supply are provided, it grows uninterruptedly.

Table 2. Bud dormancy of grapevines and bud break

	Correlative pre-dormancy	Endogenous dormancy	Exogenous post-dormancy
Principle of dormancy	Apical dominance	Chemical inhibitors	Low temperature
Induction of bud breaking	Decapitation, topping of shoot	Cool stimulus, hydrogen cyanamide	Increasing temperature

Major Points of Tropical Grape Growing

Choice of grape varieties and rootstocks

Grape varieties used for in tropical belt, should have important characteristics such resistance to fungal disease, adaptation to extreme climate conditions and high crop yield and grape quality. In this context, mostly grown grape varieties are Thompson Seedless, Black Corinth, Regina, Alphonse Lavallée, Cardinal, Perlette Emperor, Almeria, Flame Tokay, Muscat Hamburg, Muscat of Hamburg, Perle de Csaba, Ruby Seedless, Emerald Seedless and Regina for table and raisin grapes. On the other hand, Cabernet Sauvignon, Petit Syrah, Chenin Blanc, Moscato Canelli and Riesling grape varieties are chosen for wine grapes.

While choosing grape variety to grow in tropical regions, it should be paid attention to consumer demand, relationships between environment and genotype, rootstock selection which is suitable for grape variety and soil characteristics. In terms of rootstock, vigorous rootstocks such as IAC 572, IAC 313, IAC 766 and Campinas are generally preferred for table, wine and juice grapes for balanced vegetative development and raised productivity. In respect of seedless and wine grape varieties, less vigorous rootstocks like SO4 and Harmony are used for obtaining well quality grapes.

Training, trellising and pruning of grapevine

Grapevines are generally planted 3-4 m between rows and 1.5-3 m between grapevines and planting density is approximately 952-3333 plant per ha. It is utilized from the horizontal overhead-wired trellis system leading to attractive and uniform cluster (Souza Leão, 2003). The grapevines are trained to one side and then divided along the training wire to create a bilateral cordon. Later, the cross arms are alternate each side of the main arm.

The climatic variability that characterizes countries of Tropical belt inter tropical zone owing to the variations of altitude, elevation and continentally permits as

far as grape processing like juice and wine are concerned to select the production region according the type of product desired. Since *Vitis vinifera* varieties are excessively developed, pruning is essential twice a year in a cycle changing between 5 and 7 months. The technology offers the opportunity to choose between various production systems, like 1) two cycles and two harvest per year; 2) two cycles and one harvest per year; 3) five cycles and three harvests per two years or 4) five cycles and two harvests per two years depending on the production region and the precocity level of preferred varieties (Camargo, 2005). Since the risk of disease incidence is low, regions without rainfall throughout the year are suitable for production in consecutive cycles. On the other hand, regions with excessive rainy period (approximately, 5 months with rainy), it can be suggested to carry out two harvest per year with short cycle varieties in dry season in alternate years by using the system with five cycles three harvests per two years. Nevertheless, in regions that have rainy period more than 6 months, two pruning and one harvest per year and timing of production cycle for the dry period should be performed to provide well quality grapes.

Canopy management of grapevine

As known, canopy management can entail decisions about row and grapevine spacing, choice of rootstocks, training and pruning practices, irrigation and especially summer pruning activities. In tropical viticulture, it can be also utilized from common canopy management practices such as shoot thinning, shoot topping and tipping, leaf removal, cluster thinning, cluster tipping and grape thinning; if grapevines need summer pruning activities.

Diseases control

In hot climates, limiting factor to grape growing is excessive humidity and it has negative effects on grape quality, leading to

fungal diseases (e.g., mildew, anthracnose, leaf spot, rust, ripe rot and die back) and bacterial diseases (bacterial canker etc.).

In point of climate, table and wine grape varieties had better be grown in regions with low rainfall or extended dry period. On the other hand, American or hybrid varieties, whose tolerances are high to fungal diseases, should be opted in more moisture regions.

Grape harvest

Lower acid content and higher pH level of wine grapes grown under tropical climates bring about problem in wine making. So, wine grape varieties with more acid content can be preferred to solve this difficulty in grape growing in tropical regions.

Other than this, grape harvest is conducted in early morning, which is cool as usual. In grape growing in hot regions, one harvest is performed per year in the subtropics and loss of external stimuli allows growers two or three harvests per year tropics.

Conclusion

In spite of the fact that grape growing is traditionally carried out in countries with a temperate climate; there has been recently an increase in grape growing under the conditions of tropical climate. Tropical climate belt in is broadly spaced in the world and their climatic characteristics differ from temperate climate. Among the crops grown in tropical climate belt, grape and grape products have important roles for exports of countries located in tropical climate regions. Nowadays, some progress has been obtained to understand tropical ecosystems and how to manage them a view to producing needed quantity and quality of products.

In tropical regions, grapevine behavior is also different from temperate climate and by means of proper irrigation and pruning management, it can be obtained two crops per a year and harvest in this regions. Tropical viticulture permits grape growers to grape harvest in seasons of higher prices and tropic regions leads to high economic profitability in grape growing.

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