

Physiology of Field-grown Cool, Warm, and Hot-Climate Grape Varieties on the Texas High Plains

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Currently there are approximately 1,000 acres of grapevines planted on Texas High Plains. Due to location (altitude, topography, etc.) each growing season grapevines are subjected to climatic extremes. Air temperature, humidity, and wind speed can vary from day to day and from hour to hour. Leaf transpiration, vapor pressure deficit (estimate of the drying power of the air), stomatal conductance (rate of water loss through stomata), and photosynthetic rate are all influenced by climatic conditions. Because of variable climatic conditions found in the region, producers need to select grape varieties which are best adapted to climates found on the Texas High Plains. Therefore, to assist growers to select adapted varieties, evaluations must be conducted under climatic conditions found in the region. This research evaluated physiology (leaf gas exchange) of *Vitis vinifera* cool climate, warm climate, and hot climate varieties subjected to variable leaf temperatures while growing on the Texas High Plains.

Materials and Methods

Research was conducted at the Texas AgriLife Research and Extension Center vineyard in Lubbock, Texas. Varieties selected were: cool climate ('Pinot Noir'), warm climate ('Cabernet Sauvignon' and 'Merlot'), and hot climate ('Grenache' and 'Mourvedre') grafted to 110R rootstocks. The vineyard was planted in 2006 and arranged in a randomized complete block design with four blocks and five vines of each variety within each block. On seven dates during the 2008 growing season (3, 10, 12, 19, 26 June, 5, 7 August 2008) leaf transpiration, leaf-to-air vapor pressure deficit, stomatal conductance, and photosynthetic rate were measured with a LI-COR 6400 Portable Photosynthesis System on two leaves from three vines within each block. Measurements were made at leaf temperatures of 75, 83, 90, 93, 99, and 104 °F. Inside the leaf chamber light levels were maintained near 2,000 PAR. A weather station at the vineyard measured climatic data.

Results

Weather data (Figure 1) indicate daily extremes of wind speed, air temperature, shortwave radiation, and relative humidity. For each variety transpiration rate was similar at 75 and 83 °F (Figure 2). However, for leaf temperatures greater than 83 °F differences were found between varieties. At greater leaf temperatures transpiration rate for 'Cabernet Sauvignon', 'Grenache', 'Merlot', and 'Pinot Noir' were generally similar. However, transpiration rate for 'Cabernet Sauvignon' leaves was greatest at 104 °F. For each variety leaf to air vapor pressure deficit increased as leaf temperatures increased (data not shown). However, over the range of leaf temperatures leaf to air vapor pressure deficit tended to be greatest for 'Mourvedre' leaves. Stomatal conductance followed a similar but opposite trend as leaf to air vapor pressure deficit. For each variety, stomatal conductance decreased as leaf temperature increased (Figure 3). At each leaf temperature stomatal conductance for 'Mourvedre' leaves tended to be less when compared to other varieties. Stomatal conductance for 'Cabernet Sauvignon' leaves was greatest at 104 °F. Photosynthetic rate for all varieties tended to decrease as leaf temperature increased (Figure 4). However, over the range of leaf temperatures there were only a few differences between 'Cabernet Sauvignon', 'Grenache', 'Merlot', and 'Pinot Noir'. As leaf temperature increased, photosynthetic rate on 'Mourvedre' leaves tended to be less when compared to other varieties.

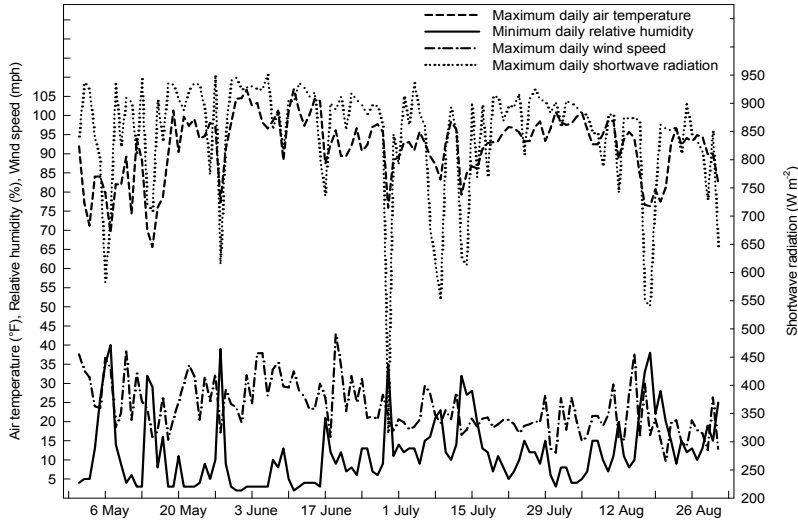


Figure 1. Climatic data for Texas AgriLife research vineyard (2008).

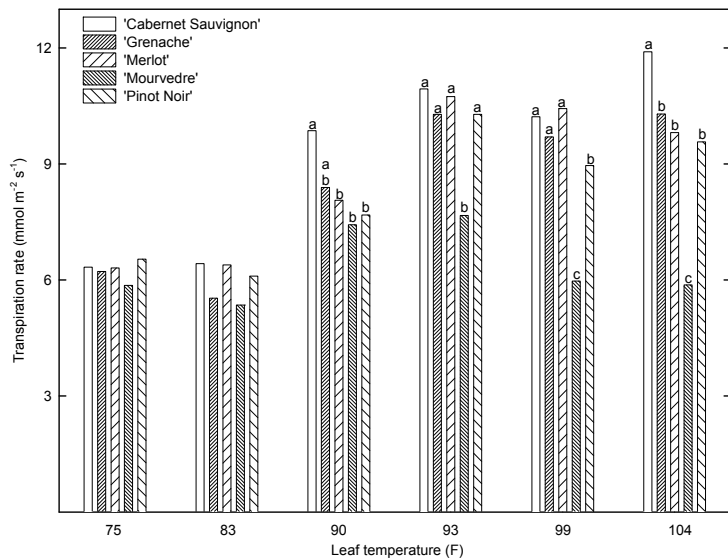


Figure 2. Transpiration rate of field grown cool ('Pinot Noir'), warm ('Cabernet Sauvignon', 'Merlot'), and hot ('Grenache', 'Mourvedre') climate grapevine varieties subject to variable leaf temperatures.

Discussion

Our data suggest under climatic conditions found during the 2008 growing season on the Texas High Plains, 'Cabernet Sauvignon' (a warm climate variety) generally maintained gas exchange (transpiration rate, stomatal conductance, and photosynthetic rate) at greater levels when compared to 'Grenache' (hot climate variety), 'Merlot' (warm climate variety), 'Mourvedre' (hot climate variety), and 'Pinot Noir' (cool season variety). However, as leaf temperatures increased gas exchange levels on leaves on 'Grenache', 'Merlot', and 'Pinot Noir' were often similar to 'Cabernet Sauvignon' leaves. Compared to other varieties, as leaf temperatures increased 'Mourvedre' (hot climate variety) maintained gas exchange at the lowest levels. Lower photosynthetic rates at greater leaf temperatures may partially explain why 'Mourvedre' fruit require a longer growing season to achieve fruit ripening.

Applications of Research

Gas exchange plays an important role in all aspects of vine and berry development. Vine growth and productivity are dependent upon assimilation of carbon dioxide (photosynthesis) and release of gases

(water and oxygen) during the photosynthetic process. On the Texas High Plains (or any region) selecting varieties adapted to the climate is critical for producing healthy vines with optimal berry production. This preliminary data suggests there are gas exchange differences between 'Cabernet Sauvignon', 'Grenache', 'Merlot', and 'Pinot Noir' varieties when subjected to various leaf temperatures. However, despite these differences these varieties appear to be able to maintain high gas exchange levels in the climate found on the Texas High Plains. Although a hot climate variety, 'Mourvedre' vines tended to have reduced gas exchange levels as leaf temperatures increased. Therefore, when compared to other varieties tested, it appears 'Mourvedre' vines react in a unique manner (lower gas exchange rates likely leads to later fruit ripening which can enhance fruit quality and flavor). Based upon our research, it appears producers need to be very selective when decisions regarding planting varieties are made, and select grape varieties adapted to their particular climate. Additional research through the 2009 growing season will give further insight to the adaptability of these varieties to the Texas High Plains climate.

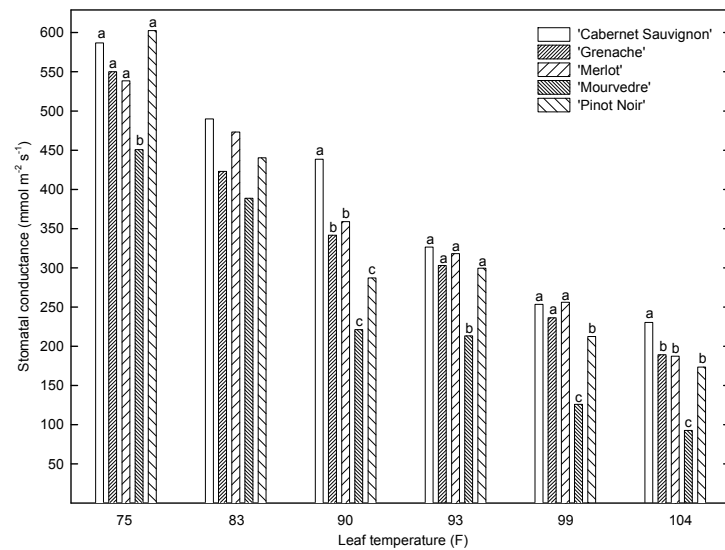


Figure 3. Stomatal conductance of field grown cool ('Pinot Noir'), warm ('Cabernet Sauvignon', 'Merlot'), and hot ('Grenache', 'Mourvedre') climate grapevine varieties subject to variable leaf temperatures.

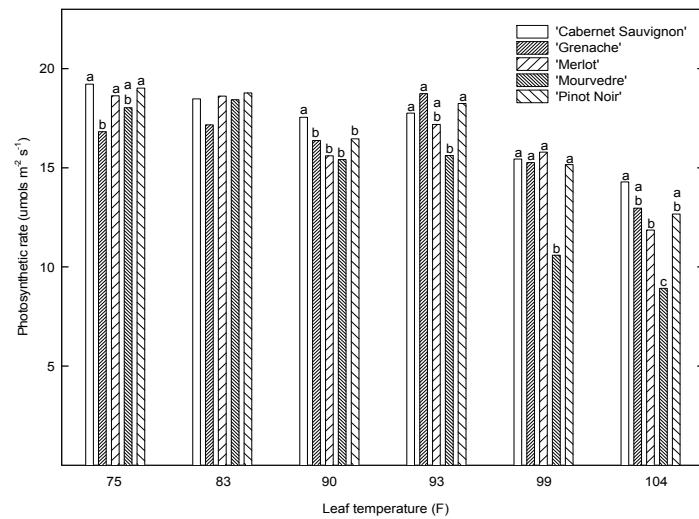


Figure 4. Photosynthetic rate of field grown cool ('Pinot Noir'), warm ('Cabernet Sauvignon', 'Merlot'), and hot ('Grenache', 'Mourvedre') climate grapevine varieties subject to variable leaf temperatures.