Summary 38

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Title: "Vine water relations, gas exchange, and vegetative growth of seventeen *Vitis* species grown under irrigated and nonirrigated conditions in California"

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The authors rank the drought tolerance of 17 *Vitis* species, including those of the arid southwestern United States, in search for candidates for future use in drought-tolerant rootstock breeding programs.

• Vines respond to drought conditions in a variety of ways, including: 1) reducing vapor conductivity through their stomates to limit water loss, 2) developing extensive root systems to find more water, 3) increasing the water conductivity of the soil-stem pathway, 4) increasing their ability to osmoregulate, which in turn, increases their water potentials, and 5) increasing their water use efficiency, that is, the amount of biomass produced per unit of water used. The more of these adaptations a given species presents, the more drought tolerant it is said to be.

• Seventeen different *Vitis* species obtained as cuttings from the United States Department of Agriculture National Clonal Germplasm Repository (Davis, California) were planted –after adequate rooting- at the Kearny Agricultural Center (Fresno, California) on a Hanford fine sandy loam with a 1.2 m hardpan, in March 1991. Five individual vines of each species were planted, using a complete randomized block design. Starting the following season, the irrigation treatments were imposed by either furrow-irrigating weekly, or not irrigating.

• At five times during the growing season, the authors performed the following measurements on both irrigated and unirrigated vines: 1) CO2 assimilation rate, 2) stomatal conductance, 3) predawn leaf water potential, 4) midday leaf water potential, 5) midday stem water potential, 6) predawn leaf osmotic potential, 7) water use efficiency (calculated as the ratio of CO2 assimilation rate and stomatal conductance), and 8) pruning weights. The authors measured 3 out of the 5 vines per treatment present.

• The authors used as "drought performance indicators" the values of these parameters in the unirrigated vines (either directly or rearranged), as well as the amount of reduction that these parameters experienced when the irrigated and unirrigated counterparts within each species were compared. The rational for the latter was that, if a vine is well adapted to drought, the change in their growth, gas exchange, water use efficiency, pruning weight, etc, when shifting from a high water status to a low water status should be imperceptible or small. For each of these indicators, they assigned to each species a value from 1 (highly drought-tolerant) to 17 (highly drought-susceptible). When added up, the total score gave the relative degree of drought tolerance of that particular species (lower values meaning highly drought resistant).

• Based on total points, *V. champinii, V. doaniana, V. longii, V. girdiana, V. arizonica,* and *V. californica* were found to be highly drought tolerant. On the opposite extreme, *V. cineria, V. lincecumii, V. berlandieri, V. riparia,* and *V. solonis* were considered the least drought tolerant. The remaining six species (*V. vinifiera, V. cordifolia, V. treleasei, V. monticola, V. rupestris,* and *V. candicans*) were considered intermediate.

• The authors compared the degree of agreement of the current results with previous drought-ranking attempts. The four most tolerant and four least tolerant species in the current study agree almost perfectly (the exception being *V. berlandieri)* with the ranking developed by Carbonneau (1985) using the ratio of the leaf area to the reciprocal of stomatal conductance as a drought indicator. However, the current ranking is in poor agreement with another study using the highest leaf water potential as drought indicator (1980). By using criteria that combine water status, gas exchange, and growth measurements, the authors hope to be using a more thorough indicator for overall drought performance.

• Finally, the authors discuss a couple of less obvious points. It is interesting that the commercial rootstocks currently classified as drought tolerant (110R, 140Ru, 1103P), are *V. berlandieri* x *V. rupestris* hybrids, both classified here as not very drought-tolerant. On the other hand, two commercial rootstocks derived from *V. champinii*, the most drought-tolerant species in this study, (Dog Ridge and Ramsey) have been classified as relatively susceptible to drought (Australian conditions). The authors believe that, even if *V. champinii* is drought-tolerant, *V. champinii* grafted to a scion deserves further studies as far as drought-tolerance and vigor imparted to that scion. The final test, which was not the focus of this study, would be to assess the yield of the producing scion when low water is available.

In summary, the authors identified six Vitis species (*V. champinii, D. doaniana, V. longii, V. girdiana, V. arizonica, V. californica*) as highly drought tolerant. These could be selected for use in breeding for tolerance, even if other tests, such as pest resistance and ease of propagation, would first need to be passed as well!

Species	**Native location**	**Drought tolerance score ***
V. champinii	Texas	50
V. doaniana	Texas (panhandle), New Mexico	80
V. longii	Kansas, Texas (panhandle)	92
V. girdiana	California (coastal to inland, Mojave desert)	94
V. arizonica	Arizona, New Mexico, Texas (Trans-Pecos)	95
V. californica	California (central valley, coastal mountain range, Sierra foothills), South Oregon	99
V. vinifera (Carignane)		105
V. cordifolia	Texas, Kansas, North and south Caroinas	111
V. treleasei	Similar to V. arizonica, but just north portion	115
V. monticola	New Mexico, Texas	125
V. rupestris	Tennessee, Texas	131
V. candicans	Texas (east and south)	131
V. solonis	Texas	138
V. riparia	Eastern, central and northern US	139
V. berlandieri	Texas, Mexico	155
V. lincecumii	Texas, Kansas	158
V. cineria	Texas, North and South Carolinas, Arizona, Montana, Kansas, Illinois	165

* The smaller the number, the more drought tolerance.

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