PHYSIOLOGICAL RESPONSE OF NEW CULTIVARS RESISTANT TO FUNGI CONFRONTED TO DROUGHT IN A SEMI-ARID MEDITERRANEAN AREA

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Abstract:

Context and purpose of the study - Water is one of the most limiting factors for viticulture in Mediterranean regions. Former researches showed that water shortage hampers both vegetative and reproductive developments. INRA is running programs to breed varieties carrying QTL of tolerance to major fungi, i.e. powdery and downy mildews. Some varieties have been already certified or are close to be certified. However, little is known about the response of these varieties to water deficit, which behavior is critical for their development. This study characterized physiological responses of 4 new varieties to water deficit and described relationship between them.

Material and methods - This experiment was carried out in 2018 the south of France at the INRA's Experimental Unit of Pech Rouge (Gruissan). Five cultivars were studied: INRA 1, 2, 3 and 4 in comparison to Syrah, all genotypes being grafted on 140Ru. Each cultivar was represented by 60 vines, with 30 vines being irrigated (I) and 30 vines without irrigation (NI). Each treatment x genotype was done in triplicated (3 x 10 vines). Irrigation was applied weekly from 3rd July until 11th September. Predawn leaf water potential (Ψ_{Pd}) was measured weekly from mid-July to mid-September. When Ψ_{Pd} between I and NI treatments were evidenced, physiological measurements –photosynthesis (*A*), stomata conductance (*gs*) and transpiration (*E*)- were weekly performed and water use efficiency (WUE= *A/E*) was calculated.

Results - In all varieties, we observed variations of Ψ_{Pd} between I and NI, with Syrah and INRA 2 showing the maximum and minimum difference respectively. *A*, *gs* and *E* decreased for all genotypes in relation with Ψ_{Pd}. Syrah showed the lowest Ψ_{Pd} (-0.66 MPa averagely), *A*, *gs* and *E*. WUE in all of the varieties, exception INRA 3, was increased as water potential decreased, but in INRA 3 WUE slightly decreased in less values of Ψ_{Pd}. The physiological parameters were classified to three level of predawn water potential: [0.2-0.4] MPa (moderate stress), [0.4-0.6] MPa (strong stress) and [0.6-0.8] MPa (severe stress) respectively. Under moderate stress, INRA 1 showed the higher *A* with 9.7 µmol m^{-2} S^{-1}, but *gs* and *E* were maximum for INRA 4. Under a severe water deficit, *A* and WUE of INRA 1 were 6.44 µmol m^{-2} S^{-1} and 2.85 respectively, which is higher than other varieties, indicating INRA 1 as the most drought tolerant variety. These first results should not be considered conclusive.

Keywords: Water deficit, new varieties, photosynthesis, water use efficiency, climate changes.

1. Introduction.

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Introduction & Objective

Water is a limiting factors in **dry or semi-arid regions**. Water shortage hampers both vegetative and reproductive developments.

INRA is running programs to breed varieties carrying QTL of **tolerance to powdery and downy mildews**. Some varieties have been already certified or are close to be certified. However, little is known about the response of these varieties to water deficit.

We studied the physiological responses of 4 new varieties to water deficit in order to assess the their potential of **water use efficiency (WUE).**

Materials & Methods

Five cultivars were studied: **INRA 1, 2, 3 and 4 in comparison to Syrah**, all genotypes being grafted on 140Ru. Each cultivar was represented by 60 vines, with 30 vines being irrigated (I) and 30 vines without irrigation (NI) in triplicates.

Predawn leaf water potential (Ψ_{Pd}) was measured weekly from mid-July to mid-September. When Ψ_{Pd} between I and NI treatments were evidenced, physiological measurements: **photosynthesis** (*A*), **stomata conductance** (*gs*) and **transpiration** (*E*) were weekly performed and **water use efficiency** (WUE= *A/E*) was calculated.

Ψ_{Pd} effect on photosynthesis, transpiration and WUE

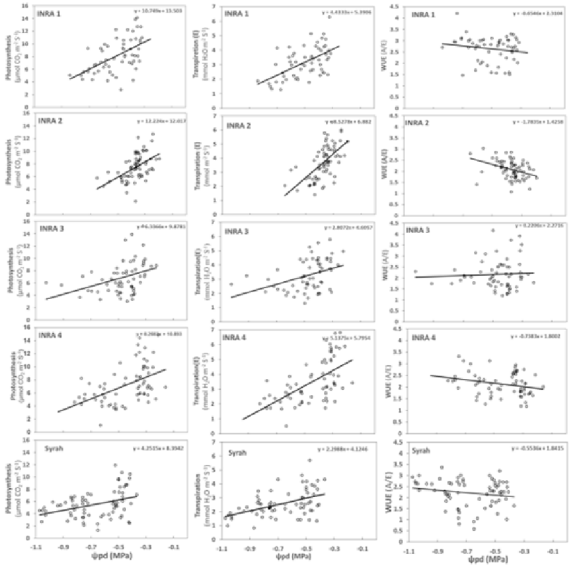

Figure 1: photosynthesis (A), Transpiration (E) and WUE (A/E) response to leaf Ψ_{Pd}

Photosynthesis (A) and transpiration (E) **decreased** for all genotypes in relation with **leaf ΨPd**. **Syrah** showed the **lowest** ΨPd (-0.66 MPa averagely), *A* and *E*. **WUE** in all of the varieties, exception INRA 3, was **increased as ΨPd decreased**, but in INRA 3 WUE slightly decreased in less values of ΨPd.

Transpiration (*E*) in water stress conditions provides an early plant response than to photosynthesis (*A*), which has been reported in numerous studies (Chaves *et al.*, 2010). **In present study, *A* decreased less rapidly than *E*, when the vine was subjected to increasing water deficit**. Increasing mesophyll limitation for CO_2 transfer inside the leaf (rm), which would reduce assimilation (Flexas *et al.*, 2007).

The **water use efficiency (WUE) increases in vines when water stress increases**, especially in INRA 2. The rise in WUE under drought conditions, tested in semi-arid Mediterranean climate, has been observed in many studies (Schultz and Stoll, 2010).

Classification values of *A*, *E* and *WUE* in levels of Ψ_{Pd}

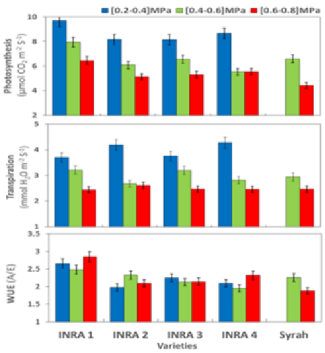

Figure 2: Classification values of *A*, *E* and **WUE** in three levels of leaf Ψ_{Pd}, [0.2 – 0.4] MPa **(moderate stress),** [0.4 – 0.6] MPa **(strong stress)** and [0.6 – 0.8] MPa **(severe stress)** for grapevine cultivars of **INRA 1, 2, 3 and 4** and **Syrah**.

The photosynthesis values of **INRA 1** in moderate stress, strong and severe stress were **more** than other varieties.

The average of **ΨPd** in **Syrah lesser** than other cultivars that was ΨPd ≤ 0.4 MPa.

Under **moderate stress**, values of **transpiration** in **INRA 4** was more than other varieties. **INRA 1** with **less transpiration** had **the most photosynthesis** that indicates high photosystem efficiency in this variety. Under **severe stress**, values of **photosynthesis** in **Syrah** was leaser than others.

INRA 1 had **the most WUE** across cultivars that was in all levels of stress 2.6, 2.4 and 2.8 respectively.

Generally, ΨPd, *A*, *E* and WUE of Syrah at water stress levels were lesser than other cultivars, so Syrah that is a sensitive genotype compared with others.

Conclusion

The high slopes of the photosynthesis and transpiration curves in relation to the Ψ_{Pd} variation indicate an important stomatal regulation in INRA 2 that does not necessarily translate into greater WUE. INRA 1 clearly shows the highest values WUE. Water stress increased mesophyll resistance (rm), to transfer CO_2 from sub-stomatal cavity towards CO_2 fixation sites where photosynthetic enzymes are located (Flexas *et al.*, 2002). These first results should not be considered conclusive.

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