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PROPOSAL ABSTRACT:

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Proposal Title:	**Acclimation and/or "stress memory" in fruit trees? Disentangling interactions between anatomy, metabolics, ecophysiology, and transcriptome in the response to recurrent drought stress in species with contrasting drought tolerance.**

Rainfall has decreased by 50% during the last century in the Regions of Atacama, Coquimbo and Valparaíso in Chile and droughts have become more frequent and sever. Actually, one of the most long lasting and severe droughts since statistics of precipitations exist in Chile has affected this area during the last years, which has led to important losses of yield, and even the abandonment, of the main fruit tree species cultivated in the area: avocados, grapevines and olives, entailing devastating socio-economic impacts. The reduction in rains and increase in droughts has been registered in many areas worldwide and is predicted to follow the same trend in the future, along with global warming. This has also been predicted to happen in the abovementioned Chilean Regions. Avocados, grapevines and olives follow a drought tolerance gradient, from drought susceptible to highly drought tolerant, respectively; which can be related to their climates of origin. Although many studies have dealt with the drought tolerance of grapevines and olives, due to their cultivation in Mediterranean climates were end of season droughts are common, less has been studied about avocados which originated in tropical climates. In all of the cases, no studies have dealt with the effect of recurrent droughts, which these fruit production systems have to face under the actual changing climatic conditions. In the case of Arabidopsis and some annual crops, the effect of recurrent stress (including droughts), has been studied. Recent studies with these species have demonstrated that plants which had been exposed to a stressing factor before, exhibited an enhanced performance under a new stress as compared to plants which had not been previously exposed to stress. Such response has been termed "stress imprint" or "stress memory" and defined as any response of a single plant after a stress experience that modifies its response towards future stress events. This stress memory has been associated with epigenetic marks which modify the transcription of the genome of the plant when it "recognizes" a stress factor it had previously experienced, leading to a faster and enhanced response. On the other hand, fruit trees, as opposed to annual species, have a long term life strategy, which allows them to significantly modify their anatomy, structure and metabolite reserves by sacrificing growth and reproduction during drought, while they wait for better conditions. This makes them develop very pronounced drought acclimation responses. In this context, an enhanced response to a recurrent drought can also be the effect of an enhanced morpho-anatomy (eg. hydraulic conductivity) and reserve accumulation which leads to enhanced water use. Therefore, studying the response to recurrent droughts in fruit trees raises a scientifically relevant question regarding if an enhanced response is due to acclamatory responses, stress "memory" or both. We here hypothesize that the contribution of both acclimation and stress memory enable an enhanced response of fruit trees to a recurring drought as compared to the response to a single drought and the degree of this enhancement increases with the drought tolerance of the species. In the aim of answering this question we will grow avocados, grapevines and olives form economically relevant cultivars (Hass, Cabernet Sauvignon and Arbequina, respectively) in 1 m^3 containers with a soil/leaf litter substrate (3/1) in the semi-arid Region of Coquimbo and submit them

to single or repeated droughts during three growing seasons, including a fully irrigated treatment. Ecophysiological variables (gas exchange, hydraulic conductivity, chlorophyll fluorescence, among others), metabolite profiles and leaf, stem and root anatomy will be measured during drought and recovery. In the case of grapevine, which is a model plant with a completely sequenced genome, we will also analyze its transcriptomic response in order to assess epigenetic markers of stress "memory". Our results also will have a technological impact because the management of drought stress "memory" via agronomical practices (eg. irrigation scheduling) may help increase the resilience of fruit production systems to drought in Chile, and worldwide. The possible effect of stress "memory" will be also tested on plants obtained from cuttings coming from unstressed and stressed mother plants which can be useful for propagating drought tolerant fruit trees. Candidate genes and epigenes of drought stress we aim at indentifying can also be useful for breeding for drought tolerant rootstocks and or varieties of these relevant fruit tree species.

Hypothesis

The contribution of both acclimation and stress memory enable an enhanced response of fruit trees to a recurring drought as compared to the response to a single drought and the degree of this enhancement increases with the drought tolerance of the species.

General Goal

To apply single and recurrent drought stress treatments to fruit trees with different drought tolerance (avocado, grapevine and olive) and compare their transcriptomic, metabolic, morpho-anatomic and ecophysiological responses.

Specific Goals

1. To compare the response of avocado, grapevine and olive root, stem and leaf growth and morpho-anatomy to single and recurrent drought.
2. To compare the metabolic profile (carbohydrates, amino acids, organic acid and xanthophylls) of avocado, grapevine and olive leaves in response to single and recurrent drought.
3. To compare the response of ecophsiological traits (gas exchange, hydraulic conductivity and chlorophyll fluorescence, osmotic adjustment and cell wall elasticity) to single and recurrent drought.
4. To sequence and compare the transcriptome of grapevine leaves subjected to single and recurrent drought.
5. To integrate the results measured in the previous objectives in order to interpret the acclimation and stress "memory" responses of the three species to drought and relate them to their drought tolerance.
6. To evaluate if plants obtained from cuttings of previously stressed mother plants exhibit higher drought tolerance than plants obtained from unstressed mother plants.