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Drought Reactions of Different Provenances of *Corylus avellana* L.

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Introduction

Corylus avellana L. is an important multi-stemmed, landscaping shrub with a wide range ecological adaptation. It has a wide distribution in Europe. It is reported to have originated from southern Europe before spreading all over with limited distributions to fewer parts outside Europe (Kasapligil, 1942; Palmé and Vendramin, 2002). Hazel nuts, *C. avellana,* are wind pollinated, with male and female flower organ maturing at different time. Pollen can be wind borne for a long distance and therefore crossing regional borders. Moreover, hazel nuts seeds can be dispersed by animals across the regions as there are no physical barriers. However, in Germany, the use of trees and shrubs in the open landscape is regulated by law (Federal Nature Conservation Act § 40). This law confines use of regional provenances trees and shrubs due to supposed genetic differences between provenances (conservation of biodiversity) and their adaptation to specific regional habitats (Jones et al., 2001; Hubert and Cundall, 2006). It is therefore, assumed that this adaptation enhances performance in the landscape. However, use of local material may not always warrant better performance as other provenances may be similar or even better stress tolerant than regional species. This is because genotype and environment interaction plays a major role in allowing the plant to adjust to a given environment (Vitasse et al., 2009). Moreover, trees and shrubs have been demonstrated to possess considerable plasticity that enables them to quickly respond physiologically and biochemically to their immediate local climate, especially a survival threatening stress like drought (Kramer, 1995; Vitasse et al., 2009).
To elucidate the plasticity of drought reactions of four provenances of *Corylus avellana* and investigate whether they differ in their physiological response we formulated the following question: Do four provenances of *Corylus avellana* differ in their physiological response to drought?

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Material and Methods

2 years old plants from four provenances of *Corylus avellana* coming from climatically different parts of Germany were used in a drought experiment under controlled conditions. The provenances used for this experiment were collected from Brandenburg (BB), Niedersachsen (NDS), Nordrhein-Westfalen (NRW) and Rheinland-Pfalz (RPF). The plant materials were carefully collected from a selected population. These plants were presumably autochthonous growing at their place for over 50 years (Bundesamt für Naturschutz, 2012). The plants from each provenance were potted into five liter containers. These plants from the four provenances were cultivated for 18 months under optimal fertilization and irrigation regimes in our container area at Leibniz University, Hannover. For our drought experiment, plants of equal size were selected and moved into a greenhouse. They were exposed to a slowly and quickly developing drought stress by controlled decreasing irrigation (either 50 % or 25 % of lost water) named as stress 1 and stress 2 respectively. Well irrigated plants served as control. The experiment was carried out in a completely randomized design with 6 or 8 replications per treatment depending on the availability of plant material. During the experiment, stomatal conductance (three measurements per plant from three leaves on the same position), pre-dawn water potential (ψp), and relative water content (RWC) were measured. The experiment was terminated when 50 % of the plants in each treatment had severely wilted.

Results

Upon imposing drought, stomata conductance (calculated as percentage from the control) of three provenances (BB, NDS and RPF) remained as high (Fig. 1) as controls for several days. However, it was followed by a sharp decline.

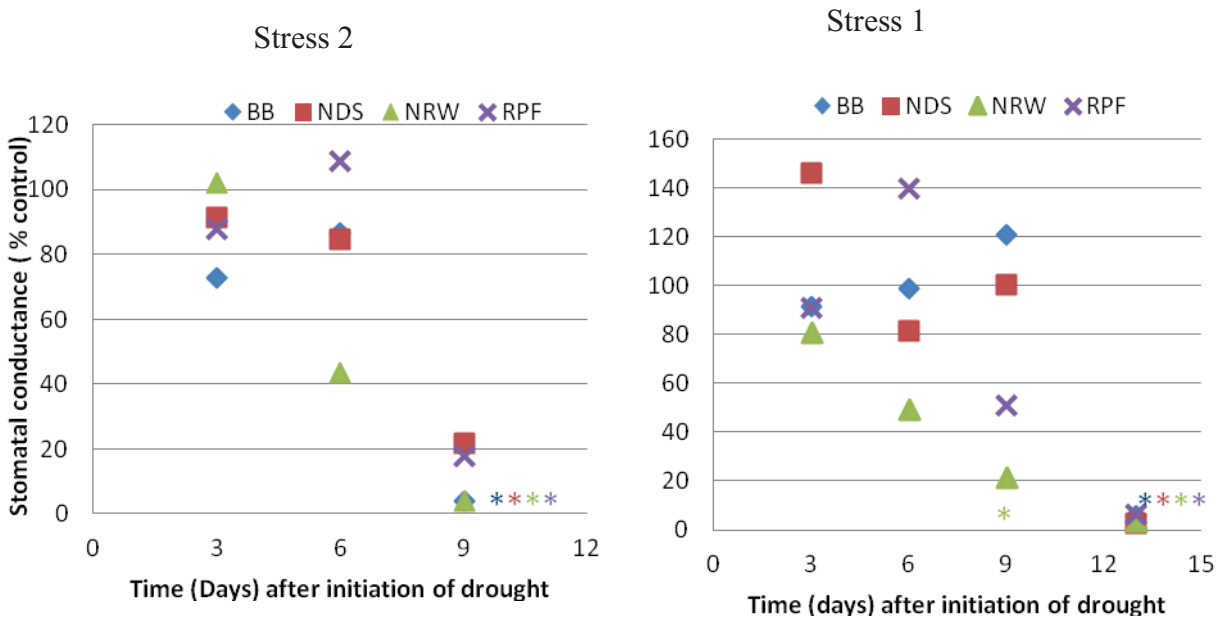

Fig. 1: Stomatal conductance (% control) of four provenances of *Corylus avellana* during drought period; Mean; n = 3 measurements during the drought period; n = 6 (BB), n = 8 (NDS, NRW and RPF) on the last day. **** indicate significant difference between the provenances stress treatment and the control using raw data (BB, NDS, NRW, and RPF) respectively. Tukey test, $p \leq 0.05$.

NRW plants on the other hand maintained their stomatal conductance low and declined gradually throughout the drought period. All provenances differed significantly with the controls only at the end of drought period (day 9 and day 13 for stress 2 and stress 1 respectively).

Most of the entire period, all provenances in stress 2 maintained high predawn water potential (Fig. 2) as well as high relative water content (Fig. 3) and differed significantly with the controls only at the end. Stress 1 plants maintained high predawn water potential and high RWC throughout the drought period. At the end of drought period only BB and NRW differed significantly with the control ψp whereas in RWC only NRW was significantly different from the controls.

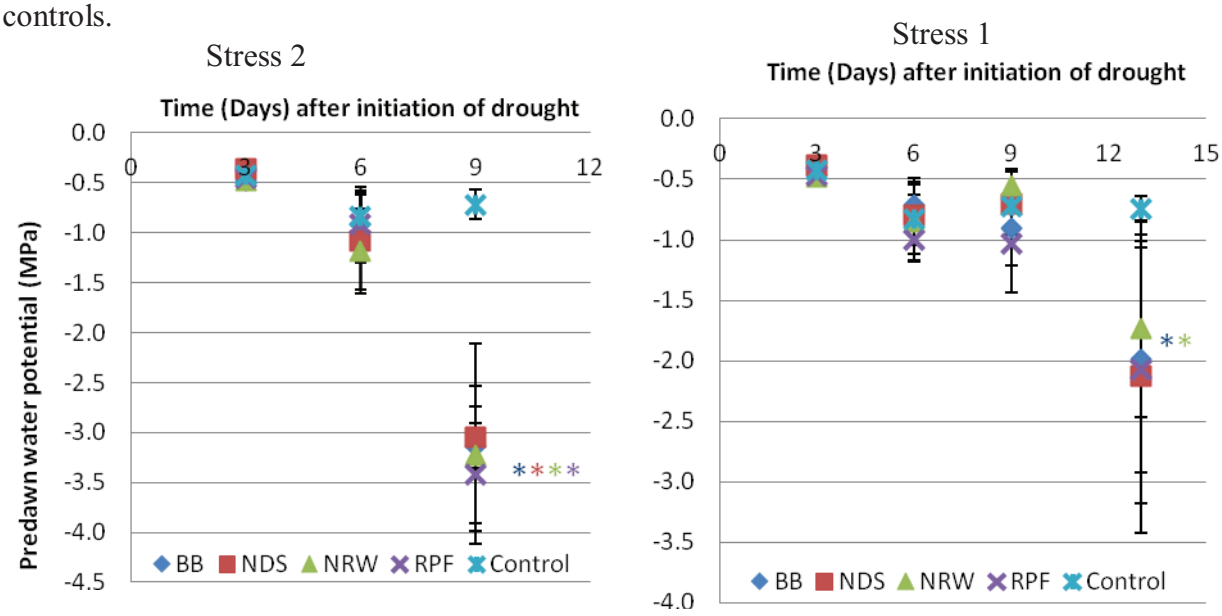

Fig. 2: Predawn water potential of four provenances of *Corylus avellana* during drought period; Mean; n = 3 measurements during the drought period; n = 6 (BB), n = 8 (NDS, NRW and RPF) on the last day. **** indicate significant difference between the provenances stress treatment and the control (BB, NDS, NRW, and RPF) respectively. Tukey test, $p \leq 0.05$.

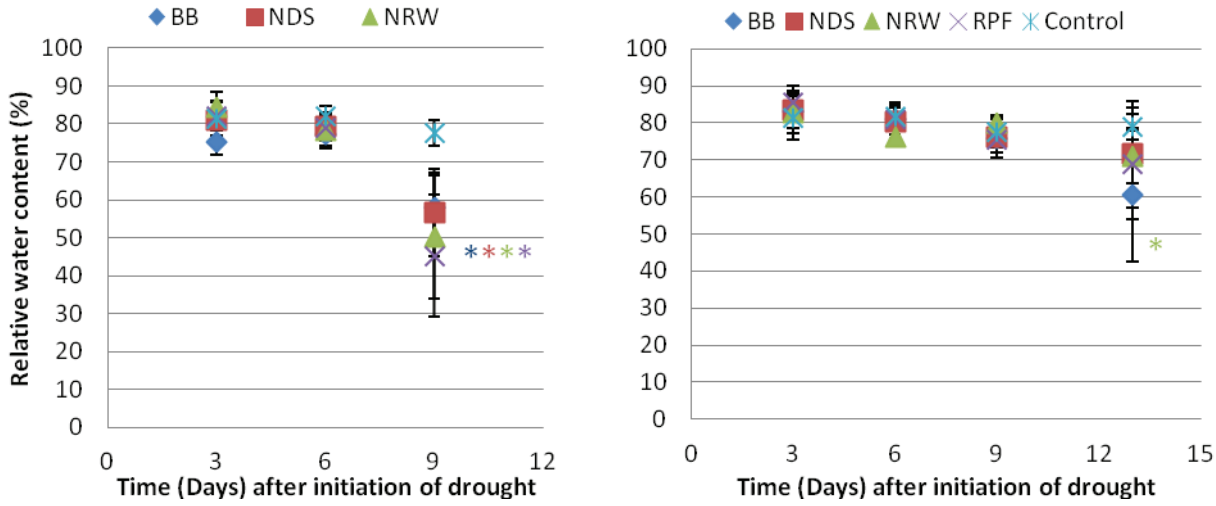

Fig. 3: Predawn water potential of four provenances of *Corylus avellana* during drought period; Mean; n = 3 measurements during the drought period; n = 6 (BB), n = 8 (NDS, NRW and RPF) on the last day. **** indicate significant difference between the provenances stress treatment and the control (BB, NDS, NRW, and RPF) respectively. Tukey test, $p \leq 0.05$.

Discussion

From the results, only at the end of the drought period, when severe wilting symptoms were visible, significant differences with the well irrigated controls were found. At this stage, there were no significant differences between the tested provenances. Although not statistically significant, during stress development stomatal conductance seems to indicate a difference in behavior of the provenances. While NRW closed its stomata already at the beginning of stress (avoidance strategy), this was not the case for BB, NDS, and RPF, which closed their stomata later (tolerance strategy) followed by a sharp decline at the end (Verslues et al., 2006). Concerning pre-dawn water potential and relative water content, all provenances behaved similarly. However, this was not expected for BB, NDS and RPF since they had marginal reduction in stomatal conductance at the beginning, instead differences in relative water content and water potential were expected.

During the experiment, there was development of ozone damage symptoms which appeared as heavy necroses when the plants were subjected to drought, although symptoms were previously hardly visible. The symptoms were few in NRW and more prevalent in BB, NDS and RPF. In the latter, severely ozone pre-damaged leaves shriveled and this might have reduced transpiration area contributing to high ψp and RWC. The pre-damage by ozone might have also affected the reaction of stomates, since the provenance with an early closure of stomate had fewer symptoms. Hence, the ozone pre-damage probably interfered with reactions, driven exclusively by drought. However, additional stress due to ozone is often coupled with high temperatures causing drought.

Conclusion

Although these provenances have recently been classified as genetically different by Leinemann et al. (2013), physiologically they were not statistically different in the measured parameters.

All provenances depicted some degree of avoidance (NRW) and /or tolerance (BB, NDS, RPF) strategy when exposed to drought. Although, there might have been an interference with previous ozone damage within the tested stress conditions, they were able to adjust physiologically independent of their origin.

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