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Anatomical basis of LMA variations drive to different photosynthetic and water storage strategies in two Sesleria species from mountain dry grasslands

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Plant and leaf traits directly affect ecosystem processes ensuring carbon, nutrient and water exchanges between soil and atmosphere through the photosynthetic activity. Nevertheless, a great within sites variation in plant and leaf traits can be found resulting in different adaptive strategies in coexisting species. Leaf mass per unit of leaf area (LMA) is an important trait to understand plant functional ecology being the outcome of leaf anatomy and related to photosynthesis. We hypothesized that LMA was the main predictor of the adaptive strategies of Sesleria nitida (S1) and Sesleria juncifolia (S2), growing on the screes and on the crests of the summit area, respectively, on Mount Terminillo (Central Apennines, Loc. Sella di Leonessa, 1895 m a.s.l.). To test our hypothesis we broke LMA down into anatomical components, leaf tissue density (LTD) and thickness (LT) and then relating them to gas exchange parameters on twenty plants per species cultivated ex situ. LTD explained 69% of LMA variations in S1 while the relationship with LT was not significant. Moreover, LTD was negatively correlated with LT in S1 driving to a 17% higher volume of the intercellular air spaces, which increases the CO_2 partial pressure at the carboxylation sites. This result was also attested by the significant relationship between LTD and both net photosynthesis per unit leaf area (Aa) and mass (Am) (R= 0.56 and -0.49, respectively), highlighting the role of LTD in determining the photosynthetic process in S1. LMA scaled with both LTD and LT explaining 82% and 70% of LMA variations in S2. Moreover, the positive relationship between LTD and LT (R2 = 0.52) highlighted a coordination between the variables in controlling the photosynthetic process. In particular, LTD and LT controlled the transactions of carbon and water through the leaf surface, being positively related to Aa (R= 0.93 and 0.79 for LTD and LT, respectively). Nevertheless, an increase in LT and LTD decreased Am (R = -0.9 and -0.8, respectively). This could be justified by the stronger control of water losses in S2 through a reduction of CO_2 diffusion due to the increase in LT and LTD, attested by 6% and 30% lower sub stomatal CO_2 concentration (Ci) and stomatal conductance (gs) compared to S1.

By analyzing variations in LMA components we demonstrated that S. nitida maximizes carbon uptake mainly by LTD reduction while S. juncifolia reduces photosynthetic capacity and maximize water storage by increasing both LTD and LT. The analysis of the components for LMA provide better insight on uptake and storage strategies of resources such as CO_2 and water by allowing the analysis of the relationship between physiological processes, leaf anatomy and environmental conditions.