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Effect of nitrogen and phosphorous fertilization on water use efficiency in a Mediterranean grassland

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Human-induced nitrogen (N) and phosphorus (P) imbalances involve complex responses concerning ecosystem structure and functioning, particularly in (semi) arid environments. Water use efficiency (WUE) defined as the ratio of gross primary productivity (GPP) and evapotranspiration (ET), is a fundamental ecosystem property linking carbon and water cycles. The increased WUE is commonly posed as an adaptive strategy to improve plant productivity under water-limited conditions. However, the plasticity of such response might be regulated by nutrient availability.

Here we will present 3-years results from a nutrient manipulation experiment conducted in a Mediterranean grassland to investigate the response of WUE under varying N and P availability. Gas exchange measurements and main environmental variables were acquired with transient-state canopy chambers during the main phenological periods. Optical and radiative properties of the vegetation were monitored with a high-resolution spectrometers (HR4000, OceanOptics, USA). Leaf area index (LAI), N and P contents were also analyzed.

Our results showed a significant increase of WUE ($P<0.05$) in response to N addition. Interestingly, the effect of fertilization was noticeable during the growing season but negligible over the dry period. Since the analysis of covariance (ANCOVA) showed that there were no significant differences in the slopes of the linear relationship between GPP and ET in the dry period ($P>0.05$). The observed differences were mostly explained by an increase in photosynthetic capacity, up to 27% and 45% increase in N and NP addition compared with the control treatment in the growing season. However, no significant differences were observed between control (no fertilization) and P addition treatments. Photosynthesis and respiration were tightly coupled across treatments regardless N addition had a pronounced impact on LAI and plant N content. The dependences and implications of surface temperature, changes in albedo, and plant community on WUE will be further explored.