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Soil nitrogen availability in the open steppe with Stipa tenacissima

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Open steppes dominated by Stipa tenacissima L. constitute one of the most representative ecosystems of the semi-arid zones of Iberian Peninsula and show a higher degree of variability in composition and structure (Maestre et al., 2007). Vegetation patchiness, which are seen as mosaics including vegetated and non-vegetated components, is a common feature of such open steppes (Valentin et al., 1999). Ecosystem functioning is strongly related to the spatial pattern of grass tussocks. Soils beneath S. tenacissima grass show higher fertility and improved microclimatic conditions, favouring the formation of "resource islands" (Maestre et al., 2007). First, soil moisture is greater beneath the clumps, due to water harvesting through rainfall interception, uptake by roots from adjacent unvegetated areas and water redistribution from gaps to clumps (Bergkamp et al., 1999; Puigdefa′ bregas et al., 1999). Second, the canopy diminishes the intense solar radiation (Maestre et al., 2001) avoiding the sun-baking effect, which is an important factor for soil temperature change and physical disruption (Magid et al., 1999). Plant clumps either functioned as microbial hotspots where enhanced microbially driven ecosystem processes took place or as microbial banks capable of undergoing a burst of activity under favourable climatic conditions (Goberna et al., 2007). The competition for water and resources between plants and microorganisms is strong and mediated trough an enormous variety of exudates and resource depletion intended to regulate soil microbial communities in the rhizosphere, control herbivory, encourage beneficial symbioses, and change chemical and physical properties in soil (Pugnaire et Armas, 2008). On the other hand there exists experimental evidence of a non-patchy distribution of certain soil microbial properties in semi-arid Mediterranean patchy ecosystems (Goberna et al., 2007). The microbial nutrient release processes have a fundamental role in ecosystem functioning, particularly in Mediterranean areas, where nutrient availability, mainly nitrogen and phosphorous, represents a limiting factor (Sardans et al., 2005) together with water availability. Soil N availability has been found to affect plant water use efficiency (Sardans et al., 2008a). This strong link between N availability and water use efficiency makes particularly important the understanding of factors affecting soil N availability in Mediterranean ecosystems in view of the future predicted increasing drought in this area.
Changes in the soil nitrogen availability in the open steppe with S. tenacissima were monitored over a two distinct period of time during the years 2008 and 2009 at a field site in semi-arid south-eastern Spain (Novosádová et al., 2010). The availability of ammonia-nitrogen and nitrate nitrogen was estimated in situ according to Binkley at Matson (1982) by the trapping of mineral N into the ion exchange resin inserted into special cover. The availability of soil ammonia-N as well as the availability of nitrate-N were in the 2008 year significantly influenced by the addition of different substrate (only 38% of control after the cellulose addition and 176% of control after the raw silk addition). In the following 2009 year was the N availability probably due to favorable soil moisture nearly the same in all experimental variants. The availability of ammonia-N was, in general, higher than the availability of nitrate-N, but the differences were less noticeable in 2008 year. It can be concluded, that the microbial competition for available nitrogen is very high and spatially and/or temporary significantly different.