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Soil CO_2 efflux in a sand grassland: contribution by root, mycorrhizal and basal respiration components

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Grasslands play an important role in global carbon cycle because of their remarkable extension and carbon storage capacity. Soil respiration takes a major part in the carbon cycle of the ecosystems; ratio of its autotrophic and heterotrophic components is important also when considering their sensitivity to environmental drivers. The aim of the study was to estimate the contribution by root, mycorrhizal and basal components to total soil CO_2 efflux.

The study was carried out in the semi-arid sandy grassland dominated by *Festuca pseudovina* at the Kiskunság National Park in Hungary (Bugac site) where C-flux measurements have been going on since 2002. The soil CO_2 effluxes were measured in the following treatments: a./ control, b./ root-exclusion, c./ root and mycorrhiza exclusion by using 80 cm long 15 cm inner diameter PVC tubes and micro-pore inox meshes. Inox mesh was used to exclude roots, but let the mycorrhiza filaments to grow into the tubes. 10 soil cores were excavated, sieved, then root-free soil was packed back layer by layer into the cores giving 6 and 4 repetitions in b and c treatments respectively. Basal respiration is referred to as the heterotrophic respiration without influence of roots or mycorrhiza. Difference between root-exclusion and root and mycorrhiza exclusion treatment gave the value of mycorrhizal respiration and control (non-disturbed) plots the total soil CO_2 efflux. The contribution by the above components was evaluated.

Soil CO_2 efflux was measured continuously by using an automated open system of 10 soil respiration chambers. Data was collected in every two hours from each treatment (one of the chambers recorded basal respiration, 3 chambers were settled on root-excluded treatments and 6 chambers measured control plots). Chambers were moved in every 2 weeks between the repetitions of the treatments. Soil CO_2 efflux (mycorrhiza-free, root free, control) data were fitted using a soil respiration model, where soil temperature, soil water content and vegetation index (NDVI) act as independent variables (mycorrhiza-free R^2 =0.7348, root free R^2=0.5850, control R^2=0.8094, $p<0.001$). Fitted parameters were used to simulate the full annual course of the different components. Manual measurements have been also done bi-weekly from 2011 to 2013 using an infrared gas analyzer (Licor LI-6400-09 LiCor Inc., Lincoln, NE, USA), to check the values measured by the open system.

The contribution of basal respiration to total soil respiration averaged 52%, ranging from 15% to 89%. The ratio of mycorrhizal respiration to total soil respiration averaged 9%, ranging from 1.8% to 30%, the proportion of root respiration averaged 39%, ranging from 0.2% to 81%. These proportions were different in growing and dormant period. The average contributions of the different components to the total soil CO_2 efflux were 65%, 17% and 18% in the growing period and 73%, 7% and 20% in the dormant period in case of basal, mycorrhizal and root respiration, respectively. We conclude that the main contributor to the total soil CO_2 efflux was the basal respiration, but root and root-associated respiration (newly assimilated carbon) exceeded it during periods of intensive growth.