STUDIES ON THE DYNAMICS OF ORGANIC SULPHUR AND CARBON

IN

PASTORAL AND CROPPING SOILS

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BHUPINDER–PAL SINGH

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ABSTRACT

Soil organic matter (SOM) can be depleted or regenerated by altering land management practices. Soil tests capable of reporting the size of dynamic SOM fractions may be useful for indicating the environmental cost of landuse and management practices. Information on the effect of land management practices on soil organic S content and turnover is scarce. This study evaluated the ability of a sequential chemical fractionation procedure to characterise changes in soil S and C organic fractions on a range of pasture and cropping soils with different management histories. The fractionation involved an initial extraction with ion exchange resins followed by dilute (0.1 M NaOH) and concentrated (1 M NaOH) alkali. In addition, recently rhizodeposited ^{14}C (root+exudate derived) produced during a short–term (one week) $^{14}CO_2$ pulse–labelling study of intact soil cores growing ryegrass/clover pastures, was used to trace the fate of root–derived C in both chemical and density fractionation procedures.

In pasture and cropped topsoils, the major amounts of soil S and C were either extracted in 0.1 M NaOH (49–69% S and 38–48% C) or remained in the alkali–insoluble residual fraction (17–38% S and 46–53% C). These two fractions were more sensitive to change caused by different landuse and management practices than the resin and 1 M NaOH fractions. With a large amount of dynamic soil C remaining in the residual fraction it was concluded that increasing strengths of alkali were not capable of sequentially fractionating S and C in SOM into decreasingly labile fractions.

The chemical fractionation allocated recent root and root–released ^{14}C amongst all the fractions. Again, most root ^{14}C appeared in the 0.1 M NaOH and residual fractions. Although small in amount, C of higher specific activity (more recently synthesised root C) was preferentially extracted by resin and 1 M NaOH extracts.

Density separation was not capable of recovering recent root and root–released ^{14}C in a single fraction. Root–derived ^{14}C was distributed between light (mostly fibrous root debris) (42%) and heavy (organics attached to clay and silt) (45%) fractions. The dispersing reagent soluble fraction recovered <13% of the ^{14}C. An anaerobic incubation and various acids and oxidising agents were tried, in order to recover a greater proportion of root and root–released ^{14}C as a single identity. These were not very successful in either

extracting or increasing the alkali solubility of the root C fraction. A 30% H_2O_2 pre-treatment of soil plus roots, or hot 1 M HNO_3 treatment of the residual fraction, were more efficient extractants of the root C fraction and should be investigated further to check their ability to better characterise soil organic S and C fractions with a change in management practices.

The $^{14}CO_2$ pulse labelling study of pasture swards showed a greater allocation of recently photo–assimilated ^{14}C to the topsoil layer with a greater proportion of ^{14}C recovered in roots than in the soil. An *in situ* soil solution sampling technique with mini Rhizon Soil Moisture Samplers™ effectively monitored the rapid appearance of a $^{14}CO_2$ pulse in soil water at various depths. A comparison of the $^{14}CO_2$ pulse labelling study under light and dark conditions indicated that, in the light lysimeters, $^{14}CO_2$ photo–assimilation/translocation/rhizosphere respiration was the main pathway for CO_2 generation at various soil depths. In the dark lysimeters, $^{14}CO_2$ diffusion was the main mechanism and ^{14}C assimilation (either photo–assimilation or assimilation by chemolithotrophs in rhizosphere soil) was small.

The $^{14}CO_2$ activity in soil water from four soil depths of dark and light soil cores, and a CO_2 diffusion model, were used to identify the $^{14}CO_2$ contribution from rhizosphere respiration in the light lysimeters. A model was developed, but the unknown geometry of the air–filled pore space in the undisturbed soil cores made it impossible to precisely calculate the contribution made by root respiration to soil water $^{14}CO_2$ activity.

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