Phosphorus loss and forms in overland flow from two representative catchments from southern Spain

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Available information about P losses in agricultural soils from southern Europe, in particular in Mediterranean areas from Spain, is scant. We studied P losses in two representative agricultural catchments under a rainfed bi-annual crop rotation located in Palma del Río (Province of Córdoba, Spain) (37°41'N, 5°18'W) between 2001 and 2002. One catchment had an extension of 60 ha and soils were mainly classified as Vertisols, with 44–50 % clay in the upper horizon and pH ranging from 7.4 to 7.9. Soils in the other catchment, with an extension of 25 ha, were mainly Alfisols, with 6–33 % clay in the upper horizon and pH between 7.4 and 8.0. Dissolved total P, and total P were determined in runoff samples (composite sample for each runoff event). Phosphorus forms in soil (18 sampling points in the Vertisol catchment and 10 in the Alfisol one) and sediments in runoff samples were studied by means of the sequential fractionation method of Ruiz et al. (1997) involving extraction with: NaOH, citrate-bicarbonate (CB), citrate (C), citrate-ascorbate (CA), citrate-bicarbonate-dithionite (CBD), acetate, and HCl. Iron extraction involved sequential extraction with of CA and CBD, which dissolve the poorly crystalline and crystalline Fe oxides, respectively.

Most (>99 %) P lost via overland flow from both catchments was particulate P. For similar runoff (~50 mm), sediment and P lost under sunflower were much higher in the Vertisol (9.7 kg P ha^{-1}) than in the Alfisol catchment (1.35 kg P ha^{-1}). The same amount of runoff in March in two consecutive years promoted a loss P of 1.35 kg ha^{-1} under sunflower (low soil coverage), and 0.35 kg ha^{-1} under wheat in the Alfisol catchment. The sum of P fractions did not differ significantly between soil and eroded sediment (4 events) in the Vertisol catchment (means 587 and 537 mg P kg^{-1}, respectively). However, the sediments from the Alfisol catchment (5 events) were significantly enriched in P (566 mg P kg^{-1}) when compared with the original soil (232 mg P kg^{-1}). The increased P content in the sediments eroded from the Alfisol was mainly related to an increased content in Fe oxides relative to the with soils: CA extractable Fe increased from 0.9 to 4 g kg^{-1}, and CBD from 6.3 to 17.1 g kg^{-1}. This explains why the Fe-related P fractions (NaOH-, CA-, and CBD-extractable) were those showing the greatest increase. The ratio of the more labile P forms (NaOH-P + CB-P) to the sum of P fractions in the eroded sediments was 0.59 in the Alfisol but only 0.21 in the Vertisol catchment. Thus, although total P loss per ha was smaller in the Alfisol than in the Vertisol catchment, the P release potential of sediments eroded from the first catchment was significantly higher, particularly under reducing conditions because Fe-related P is concentrated in the sediments. Furthermore, the sediment was more enriched in poorly crystalline Fe oxides (which are readily soluble under anoxic conditions), than in crystalline Fe oxides (more resistant to reductive dissolution). In summary, the environmental impact per unit of P lost was potentially higher in Alfisols than in Vertisols which are representative of the study area.

Ruiz, J. M., A. Delgado, and J. Torrent. 1997. Iron-relate phosphorus in overfertilized European soils. J. Environ. Qual. 26:1548–1554.