BEHAVIOUR AND FATE OF PARAQUAT APPLIED TO THE DRY ZONE RICE SOIL OF SRI LANKA

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ABSTRACT

The behaviour and the fate of paraquat entered into rice soil-water environment of the dry zone through agricultural application as a total weedicide was investigated. The kinetics and the effect of environmentally important physico-chemical parameters such as pH, paraquat concentration, background ionic strength and soil organic carbon, on adsorption and desorption processes of rice soil-paraquat system were studied by batch mode experiments using a well characterized soil sample collected from rice fields located in the command area of the Kaudulla tank in the Polonnaruwa district in order to assess the potential impact of paraquat on the environment.

The rice soil was found to be of alluvial type with a clayey texture and almost neutral properties (pH = 7.49). The point of zero charge of the soil occurred at pH = 4.07 and, thus, the soil surface carried a net negative charge at natural pH. The soil had a cation exchange capacity of 34.4 meq/100 g and organic carbon content of 1.11 %. The surface area was 170.9 m^2/g.

The adsorption kinetics of paraquat-rice soil adsorption reaction was fast having over 90 % of paraquat uptake occurred within 30 minutes. The adsorption reaction followed overall second order kinetics ($k = 1.41 \times 10^3$ l mol^{-1} s^{-1}) when both reactants were in equal concentrations.

The maximum adsorption capacity of paraquat was 10.1 mg/g of soil at pH 8.0 and 0.001 M background ionic strength. This corresponded to only 15.7 % of the cation exchange capacity of the rice soil suggesting that most of active sites were not available for paraquat. The uptake of paraquat at application level increased with increasing pH and decreasing background ionic strength and above pH 6.5, total uptake occurred irrespective of major cation concentration. Organic carbon content of the rice soil played a minor role in paraquat adsorption. Only 8 % reduction in paraquat uptake was observed for a 31.1 % reduction in the organic carbon content. The adsorption at rice soil interface obeyed Langmuir isotherm model ($k=0.0512$ l mg^{-1}).

Soil bound paraquat did not leach out to background solutions of high acidity (pH 2.3) and of high ionic strengths (1 M $NaNO_3$) when equilibrated for a duration (i.e. 7 days) that simulates the water impounding period in the recommended agricultural practice. At the normal application rate, paraquat occupies only 1.06 % of the soil sites available for paraquat annually (assuming double cropping). It would therefore, take about 60 years to produce a paraquat concentration that is lethal for fish, in water. If the factors such as about 150 fold dilution of paraquat-sorbed soil during ploughing, microbial degradation and photodecomposition were taken into account, a lethal effect would not be seen for a much longer time.