Oxidation of elemental sulfur in granular fertilizers – model and measurements

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Sulfur deficiency has become more common in the last decades and the demand for S fertilizers has increased. Elemental sulfur (ES) does not leach and has low transport cost, but only becomes available to plants after oxidation. Most studies on ES oxidation have focused on particles mixed through soil, even though commercial ES fertilizers are usually in granular form, for safety and practical reasons. While it has been recognized that co-granulation of ES decreases its oxidation rate, no attempt has been made to quantify this effect. We developed a conceptual model that predicts the 'effective diameter', i.e. the diameter of ES particles mixed through soil that would oxidize at the same rate as the granulated ES, by taking into account the effect of granulation on the effective surface area. We determined oxidation rates for a range of commercial and synthesized fertilizers in column incubation experiments at 25°C, and found that our model predicted the observed oxidation rates well. To predict oxidation of granular ES products under field conditions, also the effects of temperature and soil properties were taken into account. Estimates of ES oxidation for ES-fortified monoammonium phosphate fertilizer were made in four field trials in South- and North-America by comparing the contribution of sulfate-S and ES using a stable isotope (S-34) technique and were found to be in good agreement with the predictions made by this model. This model can be used to estimate S release from ES-fortified granular fertilizers and may hence assist in guiding fertilizer recommendations and improving fertilizer formulations.