NUCLEAR PHYSICS FOR PRECISION AGRICULTURE

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Abstract

The high-energy gamma radiation produced by the decays of ^{40}K and of daughter products of ^{238}U and ^{232}Th has enough energy and intensity to be measured in the framework of in-situ gamma-ray spectroscopy surveys. Recent applications in the field of precision farming demonstrated the exceptional capabilities of proximal radiometric measurements in estimating soil properties. In a crop field the terrestrial gamma signal measured with a NaI spectrometer, installed a few meters above the ground, is inversely correlated with soil water content and is basically insensitive to variations in cosmic radiation and soil chemical composition. In a dedicated experiment carried out in a tomato agricultural test field, gamma-ray spectra were collected continuously over a period of 7 months covering the entire crop-growing season. Reliable hourly estimates of topsoil (~ 30 cm) moisture levels with a ~2000 m^2 footprint were obtained by calibrating and correcting, with a Monte Carlo based approach, the ^{40}K gamma signal coming from the soil. A quantitative comparison with data simulated by different soil–crop system models showed that proximal gamma-ray spectroscopy could be an effective tool for rational use of water resource and irrigation planning.

Keywords: gamma-ray spectroscopy, soil water content, NaI spectrometer, potassium-40, precision agriculture, Monte Carlo simulation