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# The Measurement of Fertilizer use Efficiency by Liquid Scintillation Counting Method

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The application of radionuclides as tracers for the measurement of fertilizer use efficiency are well documented [1-4]. Some examples are the application of chemical fertilizer sources labelled with 32P, 33P and 35S. When a radioisotope-labelled fertilizer is added to the soil, the soluble fraction of a radionuclide label of this element source of a chemical fertilizer undergoes isotope dilution with elements of soil solution . On the basis of this isotope dilution in the soil solution and the selective uptake of soil and fertilizer elements by plant roots, the specific activity of the isotope label in the plant crop is used to measure the fertilizer use efficiency by plant crops.

The double-label 32P-35S has been applied to sulphur and phosphorous fertilizer sources for studies of fertilizer use efficiency by plant crops [7]. The application of double-labelled radioisotope sources of phosphorous and sulphur to studies of fertilizer use efficiency provides the advantage of reducing the experimental variability in the measurements of the availability of these elements to test crops. Test crops will vary from plant to plant in their abilities to take up nutrient elements, and this variability will also be a function of the specific location of the plant in the field, the soil moisture content and other chemical and physical properties of the soil where a specific plant may be located. This experimental variability is reduced by increasing the number of test plants or treatment replicates in pot experiments or the number of experimental field plots and their locations over the testing fields. In studies involving the application of isotopes to measure the availability of more than one fertilizer and soil element to plant crops experimental variability is reduced when a given test crop is exposed simultaneously of each of isotope sources, because a given plant root with its unique rhizosphere would see simultaneously all sources of the nutrient elements. Also multiple isotope labels in studies of fertilizers use efficiency can reduce research cost, as separate experiments need not be conducted for each chemical fertilizer source.

The major elements of chemical fertilizers are nitrogen, phosphorous, potassium and sulphur, which are major nutrients for crop plants. The concentrations of the first three of these elements in chemical fertilizers are often noted on the label of fertilizer containers as %N-P-K. The stable isotope 15N and the radionuclide 32P are used as tracer for the measurement of nitrogen and phosphorous fertilizer use efficiency[2, 8]. Potassium is an important nutrient element of chemical fertilizers, and it will affect the uptake of other elements by crop plants [9]. There is no suitable isotope of potassium available. But due to similarities in the soil chemistry of rubidium and potassium, the radionuclide 86Rb has been used a tracer for potassium[2].

In the meantime, in recent years, beta energy detection system using liquid scintillation counter undergoes significant progress by utilization of TDCR (Triple to Double Coincidence Ratio) a detector with three photomultiplier tubes (PMT) instead of two as utilized before. Currently a Liquid Scintillation Counter (LSC) that has been using TDCR is Hidex 300 SL, made by Hydex Oy company from Finland. Wanke et al, 2012 has been investigating TDCR performance using free parameter models and concluded that measurement results showed a comparable to those obtained with other technique [10]. One advantage of TDCR application is to eliminate luminescence originated from alkalinity found in many liquid scintillation cocktail. Traditionally two PMT coincidence counter may result random coincidence producing unwanted signal. TDCR does not require an external source in correcting quenching effects in measurement.

In conclusion, due to important progress of its instrumentation system, utilization of liquid scintillation counter for identification of low radiation level of beta energy will be more favorable in the future.

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**Alfian Noor** is currently head of Radiation Chemistry Laboratory of Hasanuddin University, Makassar, Indonesia. Professor Noor, after holding BSc (Sarjana) degree from ITB Indonesia, obtained his master degree (MSc) in nuclear chemistry from Washington State University, Pullman, USA and Docteur en Science (Dr) in the field of marine environmental chemistry from Aix Marseille University, Marseille, France. He is also an active member of American Chemical Society (ACS), Indonesian Chemical Society (ICS), and International Biometal Society (IBS). He has developed many cooperative actions, among them are with IAEA (International Atomic Energy Agency) and FAO (Food Agriculture Organization) in the field of application of nuclear science and technology in developing crop productivity in high saline coastal area where Indonesia has potential coast length of not less than eighty one thousand kilometers. He also lead Buginesia Programme, a research project on biogeological exploration in Spermonde Archipelago an area of sixteen thousand square kilometers. Buginesia Programme is cooperative research between Hasanuddin University along with National Research Institute (LIPI) with seven universities and research institutions in The Netherlands such as Natural History Museum, Leiden, Utrecht University, Utrecht, Groningen University, Groningen, Leiden University, Leiden, University of Amsterdam, Amsterdam, Radboud University, Nijmegen, and Agricultural University, Wageningen. He was the dean of Faculty of Mathematics and Natural Sciences of Hasanuddin University between 2005-2009 and head of department of chemistry in 1990 to 1993.

Alfian Noor says 'my main interest is to combine marine sciences and chemistry towards better understanding on marine chemistry' and it is therefore he also establishes a trilingual journal (in English, French, and Indonesian) called 'marina chimica acta' that accomodates close interlinking among problems in marine related fields such as pharmacy, fishery, environment, geology, mining, hydrocarbons, and even archeology all with chemistry. In educational research, he has supervised hundreds of undergraduate research students, more than thirty master students and about fifteen doctoral researchers. In the field of marine environment research focus is given to metal role in sponge, seagrass, as well as coral reef. Currently carbon fourteen (C14) study is being carried out relating to age determination and its genesis in reef platform of Spermonde archipel in cooperation with some international research institutions in Australia and Europe. Alfian Noor has many experiences as visiting scientists in Monaco Environment Laboratory (MEL) which belongs to IAEA, Senior Scientist at Natural History Museum, Leiden, Senior Scientist at University of Bremen, Germany, Visiting Professor at Kitasato University, Iwate, Japan, and Guest Professor at Griffith University, Goldcoast, Australia. He is also Scientific Expert for IAEA. His wife is a pharmacist and blessed with two son.