SHORT COMMUNICATION

Counting Emissions from Potassium-42 in Plant Tissue with a Liquid Scintillation Spectrometer

Introduction

Short-term soil fertility experiments with K^{42} used as a tracer resulted in the need for an efficient, automatic counting method with accurate decay corrections. This paper describes a method for preparing plant tissue for liquid scintillation counting and gives reference to statistical analysis of the counts by computer. The method has been used to measure 'A' values of K over a growing period of 6 days for comparison with other indexes of soil K-availability [5] [6].

Materials and methods

In a first experiment, plant material was ashed directly in the counting vials, but this resulted in variability due to differences in color (color quenching)[1]. Therefore, the following method was devised to keep color a constant factor by ashing and folding samples in aluminium foil. Squares of aluminium foil, 1–3/4 × 1–3/4 inches, were cut out and formed into a dish. One-quarter of a gram of plant material was weighed into each dish. The dishes were placed in a muffle furnace and dry ashed by raising the temperature slowly to 400° C over a period of two hours. The dishes were removed from the furnace, cooled, folded into wafers and suspended in liquid scintillator from wires attached to the screw caps of the scintillation vials. The liquid scintillator was made up from 4 g of PPO (2, 5-diphenyloxazole) and 0.1 g of POPOP (2, 2-p-phenylenebis (5-phenyloxazole)) per liter of toluene.

Standard samples were prepared by weighing 0.25 g of plant material grown from check treatments into aluminium dishes and by adding up to 0.5 ml of tagged fertilizer solution. The preparation of the fertilizer solution is described elsewhere [5] [6]. The samples were dried in an oven at 70° C and then ashed in a muffle furnace as previously described.

The samples were placed on a turntable of a Model 314EX Tri-Carb scintillation spectrometer, and allowed to cool for one-half hour. Each sample was counted at one to five minute intervals seven or more times and until the total count exceeded 1000 counts to give a statistical error of 3 per cent or less. The results were printed out by a digital printer and both counts and time were punched onto computer cards. Each sample was counted again an equal

number of times at least one week later when the amount of K^{42} left was negligible. This gave the individual background count per sample. Counting efficiency was calculated from the specific activity of the source determined by survey meter and from counts of standard samples.

Calculations

The radioactive isotope K^{42} has a half-life of $12.42 \pm .03$ hours [7]. In counting samples containing this isotope for any period of time, accurate decay corrections are necessary for precise measurements. A computer program [5] was written to calculate the weighted mean of the counts for each sample. The program was written to calculate also the standard deviation of the mean, percentage standard deviation of the mean and Chi-square value based on statistics by Guest [3]. The statistical calculations were incorporated into the program to determine the precision of the counting technique.

The following equation was used for decay correction:

$$a_i = (R_i - \bar{B})e^{\gamma t_i}$$

where

a_i = counts of sample corrected back to arbitrary time zero, t_0,

R_i = counts of sample including background at the time of t_i,

λ = decay constant for radioactive isotope $(K^{42}, \lambda = 9.241 \times 10^{-4}/\text{minute})$,

t_i = time of count from arbitrary time, t_0,

$\bar{B}$ = mean background count, $\Sigma b_i/n$, b_i = background counts.

Results and discussion

Plant material ashed in aluminium dishes and folded into aluminium wafers provided a bright reflecting surface and no difference in color between samples. Thus, quenching due to color was constant and probably negligible in reducing efficiency of counting emissions from K^{42}-samples. Counting efficiency was approximately 70%.

The thickness of the wafers was nearly constant, $2.98 \pm 0.04\%$ of the range of the electrons emitted as measured on six wafers. Seepage of liquid scintillator into the wafers increased the effective thickness to $4.40 \pm 0.02\%$ of the range. According to Friedlander and Kennedy [2], self-absorption of electrons emitted from a radioactive source may be considered negligible in measurements not demanding the greatest precision, if the absorber thickness is less than 1% of the range of electrons. If the absorber thickness is greater than 1%, it is advisable to standardize the thickness at a fixed value and test the precision of the method.

The counts of four standard samples are shown in Table 1. Calculated coefficient of variation among four standards having the same quantity of activity present was 1.6%. These measurements were considered to be precise enough for K-uptake studies and were more precise than duplicate analysis of corn-leaf samples measured by MacKay and DeLong [4].

TABLE 1

Counts of standard samples ashed in aluminium dishes			
Sample number	Mean count $(\bar{a}_w)$ (counted 11 times)	Standard deviation (s_w)	Percentage standard deviation $(\% \, s_w)$
	cpm		
1	2519	15.3	0.6
2	2472	13.2	0.5
3	2430	12.6	0.5
4	2500	12.0	0.5
Mean*	2480		

* The standard deviation for the 4 samples equals 38.7, the coefficient of variation among standard samples is 1.6%.

Summary

A method has been devised to count emissions from K^{42} in plant tissue by liquid scintillation spectrometer with low quenching. The plant samples were ashed in aluminium dishes, folded into aluminium wafers and suspended in the liquid scintillator of counting vials. The samples were counted in a scintillation spectrometer at one to five minute intervals seven or more times and until the total exceeded 1000 counts. The efficiency of counting was approximately 70%.

A computer program was written to calculate decay corrections for the short half-life isotope K^{42}. The program computed the weighted mean of the counts, standard deviation of the mean, percentage standard deviation of the mean and Chi-square value for each sample. The measurements were precise enough for K-uptake studies.

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Received January 24, 1966

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