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DETERMINATION OF POTASSIUM IN GRASSES AND  
LEGUMES BY SPECIFIC ION ELECTRODE

By H. R. WILLIAMS, B.Sc., and G. F. HAYDON, B.Sc.

SUMMARY

A rapid method for the determination of plant potassium is presented. It involves the use of a liquid membrane potassium electrode with water extraction. Tri-acid digestion is satisfactory but is slower than water extraction. The electrode method is as accurate as the slower flame photometry method for both extraction techniques.

I. INTRODUCTION

Plant potassium is normally extracted by a wet acid digest technique or by a dry ash procedure in which the ash is taken up in HCl. Readings are generally done by flame photometry. The potassium electrode offered a simpler procedure and its suitability was investigated.

II. MATERIALS AND METHODS

*Equipment.*—The specific ion electrode used was a Philips Liquid Membrane Potassium Electrode No. 15560-K. It was used in conjunction with a Philips ground glass junction Reference Electrode No. R44/2-SD/1.

The specific ion meter used was a Townson Specific Ion/pH Meter No. 1950. This is fitted with a direct reading log scale graduated from 1 to 10 over each of two decades. The instrument was set up with the lower standard (i.e. 10 p.p.m.) on centre scale, then full deflection (1 decade) on the left-hand end of the scale was calibrated at 100 p.p.m. Full deflection to the right-hand end of the scale thus read 1 p.p.m. For the sample weights and dilutions used, the decade representing 10–100 p.p.m. was selected as being suitable for the normal range of plant potassium levels.

*Reagents.*—All reagents used were of Analytical Reagent grade. They were (a) 1 000 p.p.m. solution of potassium as potassium nitrate; concentrated sulphuric acid; concentrated nitric acid; and perchloric acid 72%.

*Plant material.*—Five common pasture species—two grasses and three legumes—were selected for testing. They were curly Mitchell grass (*Astrebla lappacea*), pangola grass (*Digitaria decumbens*), Siratro (*Macroptilium atropurpureum*), desmodium (*Desmodium intortum*) and glycine (*Glycine wightii*).

*Extraction methods.*—Two methods of extraction were compared—tri-acid digestion and water extraction. For the tri-acid digest, 0.5 g of sample was digested and made to a final volume of 250 ml. For the water extract, 0.5 g was boiled in about 100 ml distilled water for 30 min, cooled, then made to a final volume of 250 ml.

In each case, expected potassium levels of between 1 and 3% would be equivalent to levels of between 20 and 60 p.p.m. in solution. All solutions were filtered prior to electrode measurement.

In the case of the tri-acid digest the standards were made to the same strength in acid as the samples. In the case of the water extract the standards used were made up in distilled water.

*Electrode measurement.*—In both cases the decade 10–100 p.p.m. was calibrated with standards. Intermediate standards of 25, 50 and 75 p.p.m. were used to check the linearity of the system. The EEL flame photometer was calibrated at 0, 5, 10, 15 and 20 p.p.m. intermediates. Extracts were diluted suitably.

### III. RESULTS

The results of the tests are shown in Table 1. All results were subjected to Analysis of Variance, which revealed that there were no significant differences at the 5% probability level between extractions or methods of determination.

TABLE 1

COMPARISON OF FLAME PHOTOMETER AND SPECIFIC ION ELECTRODE METHODS FOR DETERMINATION OF POTASSIUM IN BOTH AQUEOUS EXTRACT AND TRI-ACID DIGEST

Sample	AQUEOUS EXTRACT (%K)						TRI-ACID DIGEST (%K)					
	FLAME PHOTOMETER			ELECTRODE			FLAME PHOTOMETER			ELECTRODE		
	Mean	S.D.*	C.V.†	Mean	S.D.	C.V.	Mean	S.D.	C.V.	Mean	S.D.	C.V.
1	1.2	0.014	1.1	1.22	.04	3.7	1.2	.014	1.1	1.15	.05	4.3
2	0.98	.035	3.6	1.02	.027	2.6	1.03	.043	4.2	0.99	0.04	4.2
3	2.87	.044	0.95	2.83	.027	0.96	2.87	.032	1.1	2.8	.07	2.5
4	2.16	.07	3.2	2.05	0.099	4.9	2.21	.026	1.2	2.1	0.08	4.7
5	2.54	.035	1.4	2.56	.044	1.9	2.57	.027	1.0	2.59	.071	2.7

\* Standard deviation. † Coefficient of variation.

### IV. DISCUSSION

The investigation revealed that the potassium electrode is a satisfactory method for the determination of plant potassium, particularly if used in conjunction with a simple water extraction, which is rapid.

The liquid membrane system used is based on the principle that the ion exchange takes place in the body of the membrane. Because there is no reservoir of ion exchange liquid behind the membrane, its life is relatively short. The membrane/ion exchange liquid lasts from 2 to 4 weeks. Changeover is simple and rapid as well as being comparatively inexpensive.

Care needs to be taken in the use of the electrode soon after replacing the ion exchange liquid and the membrane. Surplus ion exchange liquid is used and the excess should be allowed to seep out for approximately half an hour; the face of the membrane should then be firmly wiped with a tissue prior to use.

The neutral ligand, valinomycin, dissolved in diphenyl ether is the ion exchange liquid. An excess of diphenyl ether on the membrane surface leads to low and irregular results.