

The Incorporation of Potassium Antimony Tartrate in Molybdenum Blue Method for the Automated Colorimetric Determination of Available Phosphorus in Soils

S.M.I. TIONG

Taiko Plantations Sdn. Bhd.,

Locked Bag No. 3,

91009 Tawau, Sabah, Malaysia

Key words: Potassium antimony tartrate; soil P determinations.

ABSTRAK

Penambahan Kalium Antimoni Tartarik ($KSbOC_4H_4O_9$) dalam kaedah biru-asid askorbik untuk penentuan forforus (P) yang diekstrak secara Bray dan Kurtz No. 2 telah dikaji. Keputusan berdasarkan kaedah tersebut bersamaan dengan kaedah-kaedah Fogg dan Wilkinson dan Stanum Klorida.

ABSTRACT

The incorporation of potassium antimony tartrate ($KSbOC_4H_4O_9$) in molybdenum blue-ascorbic acid (Mo blue) method for phosphorus (P) determination of Bray & Kurtz No. 2 soil extract was studied. Results obtained by this method are in close agreement with those by Fogg and Wilkinson and Stannous Chloride manual methods.

INTRODUCTION

Several automated methods based on Mo blue-ascorbic acid procedure for the analysis of P in Bray & Kurtz No. 2 extract have been published. Lacy (1965) used a method based on the ascorbic acid reduction technique of Fogg and Wilkinson (1958). Ng (1970) also used a modified ascorbic acid method for the analysis. Grigg (1975) adopted a colorimetric method described by Murphy and Riley (1962). All these method however, involved heating of a solution to a high temperature to speed color development. This manner of color development is undesirable and should be avoided as Salt (1968) has shown that hydrolysis of organic phosphate occurs under such a condition.

The method described in this paper successfully overcame the problem mentioned. The procedure employed is the modification of Ng method with the incorporation of potassium

antimony tartrate to speed color development at room temperature.

MATERIALS AND METHODS

Apparatus

Technicon Autoanalyser II and Pye Unicam Ultra-violet/Visible Spectrophotometer were used.

Reagents

All solutions were prepared from analytical reagent grade materials. The following reagents were prepared:

1. Extracting solution — 0.03N $NH_4F/O. HCl$ 100ml of 1N HCl solution and 30ml 1N NH_4F were mixed and made to liter. The solution was adjusted to pH = 1.8.
2. Boric acid — 0.8M (to suppress fluoride intererence).



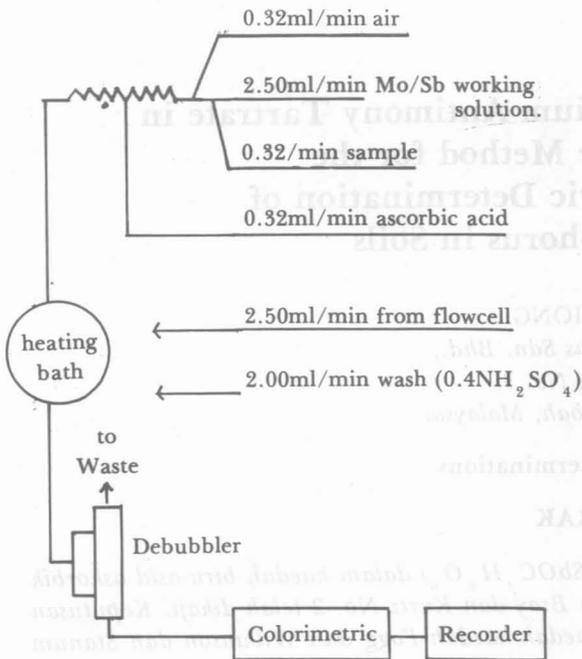


Fig. 1: Diagram of manifold used to determine Bray & Kurtz No. 2 P in soil extract.

49.46g of boric acid was dissolved in about 500ml of hot water and made up to a liter when cooled.

3. Ammonium Molybdate/KSbOC₄H₄O₆ (Mo/Sb) stock solution.

25.00g of ammonium molybdate was dissolved in about 300ml of water and heated to about 60°C. 280ml of concentrated sulphuric acid was diluted to about 600ml. After both the solutions had cooled, they were combined. 0.80g of potassium antimony tartrate was dissolved in the combined solutions after it had cooled to room temperature and the solution made to a liter with distilled water.

4. Ammonium molybdate/KSbOC₄H₄O₆ (Mo/Sb) working solution.

50ml of the stock solution was added to 150ml of boric acid and the mixture was diluted to a liter.

5. Ascorbic acid — 0.5%.

0.50g of ascorbic acid was dissolved in 100ml of distilled water.

6. Sulphuric acid, 0.4N (wash solution).

11.0ml of concentrated sulphuric acid was

diluted to a liter and 5 drops of Levor IV added as wetting agent.

7. Working standards.

Standards of 0 to 10mgP/l were prepared in the extracting solution.

Procedure

20ml of the extracting solution was added to 2g soil (60 mesh) in a test-tube (1×8") and shaken by wrist inversion at 2 second/inversion for 1 minute, i.e. 30 inversions per minute. On completing the process, the extract was left to stand for one minute before filtering through Whatman No. 2 filter paper.

Determination

The manifold for the analysis is shown in Figure 1. The 0 to 10mgP/l was achieved by using 0.32ml/min sample line.

The sampling rate was set to 50 samples/hour and filters of 660nm were used. The temperature of heating bath was that of room temperature.

RESULTS AND DISCUSSION

Results of twelve selected soil samples to cover the common range of values are given in Table 1. All determinations were carried out in duplicate. The results showed that for soil with low P values, i.e. about 5 p.p.m., the Fogg and Wilkinson method gave higher results compared with either ammonium molybdate/KSbOC₄H₄O₆ or Stannous Chloride method which agreed well.

According to Salt, the heating of solution to develop the color hydrolysed organic phosphorus from low P soil will give significantly more inorganic phosphorus.

The concentration of potassium antimony tartrate in the ammonium molybdate/KSbOC₄H₄O₆ method described is sufficient to give a linear calibration graph of up to 10mgP/l. The standard calibration was adjusted to 5.00 and 1.00 unit(s) for standards ranging 0 to 4mgP/l and 0 to 10mgP/l, respectively.

Grigg recommended that the modules should be connected by glass tubing where possible, and a washout of the manifold with 10% sodium hydroxide solution should be adopted to prevent slight baseline drift.

TABLE 1
Comparison of results using different procedures for Bray — Kurtz No. 2 soil extract

| Sample number | Mo/Sb Autoanalyser | | Fogg & Wilkinson manual | | Stannous Chloride manual | |
|---------------|--------------------|------|-------------------------|------|--------------------------|------|
| | Mean (p.p.m.) | S.D. | Mean (p.p.m.) | S.D. | Mean (p.p.m.) | S.D. |
| 1 | 1.5 | 0.25 | 2.1 | 0.92 | 1.7 | 0.50 |
| 2 | 2.0 | 0.72 | 2.5 | 1.95 | 2.2 | 0.27 |
| 3 | 2.4 | 0.68 | 2.8 | 0.68 | 2.4 | 0.71 |
| 4 | 4.1 | 0.31 | 4.6 | 0.74 | 4.0 | 0.30 |
| 5 | 4.4 | 0.63 | 5.1 | 1.00 | 4.6 | 0.90 |
| 6 | 4.6 | 1.50 | 5.0 | 0.81 | 4.8 | 0.59 |
| 7 | 7.9 | 1.15 | 7.5 | 1.05 | 7.5 | 1.20 |
| 8 | 12.4 | 1.07 | 12.2 | 1.72 | 12.8 | 1.00 |
| 9 | 17.3 | 1.06 | 18.0 | 1.56 | 17.9 | 1.73 |
| 10 | 20.4 | 1.00 | 20.0 | 1.85 | 19.9 | 1.01 |
| 11 | 25.0 | 1.94 | 25.7 | 1.07 | 25.2 | 1.99 |
| 12 | 49.7 | 2.00 | 50.1 | 2.05 | 50.0 | 2.50 |

CONCLUSION

The improved method which involves incorporation of potassium antimony tartrate is suitable for providing rapid and accurate phosphorus determination of Bray and Kurtz No. 2 soil extract. No heating is required for color development and therefore the question of hydrolysis of organic phosphorus does not arise.

ACKNOWLEDGEMENT

The author wishes to thank the management of Taiko Plantations Sdn. Bhd. for permission to publish this paper.

REFERENCES

- LACY, J. (1965): *The Analyst*. **90**: 65 — 70.
- FOGG, D.N. and WILKINSON. (1958): The colorimetric determination of phosphorus. *The Analyst*. **83**: 406 — 414.
- NG, S.K. (1970): Automated determination of content of soils under rubber cultivation. *J. Sci. Fd. Agric.* **21**: 275 — 278.
- GRIGG, J.L. (1975): Commun. in Soil Science and Plant Analysis. **6**(2): 95 — 112.
- MURPHY J. and J.P. RILEY. (1962): A modified single solution method for the determination of phosphate in natural waters. *Anal. Chim. Acta*. **27**: 31 — 36.
- SALT, P.D. (1968): The automated determination of phosphorus in extracts of soil made with 0.5M sodium hydrogen carbonate and 0.01M calcium chloride. *Chemistry and Industry*. **18**: 584 — 586.

(Received 27 August, 1986)