Determination of 'total' N and 'total' P in a single soil digest

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Abstract. A digestion method in use for multi-element plant analysis was tested for its applicability to soil analysis. It proved possible to determine N and P in one digest.
Key-words: soil analysis, soil digestion, 'total' N, 'total' P.

Introduction. In order to characterize the nutrient content of soils, many soil samples have to be analysed both for 'total' N and 'total' P. Up till now, a different digestion procedure was used for either element in our laboratory: for 'total' N the Kjeldahl procedure (Hesse, 1971) and for 'total' P a digestion with conc. H_2SO_4 and conc. HNO_3 (1:1). Recently, however, a method has been developed for the determination of, among others, nitrogen and phosphorus in plant material after one and the same digestion (Novozamsky et al., 1983). This technique has now been tested for its applicability to soil.

The digestion mixture consists of H_2SO_4 (ϱ = 1.84 g cm^{-3}) in which 3.5 g Se and 72 g salicylic acid per litre have been dissolved. The digestion procedure involves a pre-heating stage at 100 °C in order to avoid loss of nitrate. Next, H_2O_2 is added to oxidize the larger part of organic matter. The rest is oxidized by the H_2SO_4 at 330 °C. To 0.4 g of finely ground soil 2.5 ml of this digestion mixture is added (F. Kadijk, personal communication). The ratio is chosen so that the final acidity of the diluted digest is suitable for the colorimetric determination of both N and P. After the digestion the volume is made up to 50 ml.

For the nitrogen determination in the digest (as NH_4^+) a modification of the Berthelot reaction is used (van Eck et al., 1981; Novozamsky et al., 1974) and the phosphate is determined by the molybdenum blue method (Murphy & Riley, 1962; van Schouwenburg & Walinga, 1967). In the latter method, a yellow complex of heteropolyphosphomolybdate is formed in an acid medium containing both molybdate and orthophosphate. The complex can be reduced yielding a characteristic blue colour with a maximum absorption in the NIR at 880 nm.

No problems were encountered with the nitrogen determination. In the case of phosphorus, however, the turbidity caused by elemental selenium, formed during the reduction step, rendered a spectrophotometric determination of phosphorus impossible. To overcome this problem, it was tried to prevent the flocculation of elemental Se by addition of a protective agent. Two of the compounds studied proved to be effective, namely acacia and Aerosol 22.

Experimental (P determination)

Reagents

1. *Protective agents.*

a. Aerosol 22 (an octylsulphonate detergent): Technicon Chemicals Co. product No T21-0300-15

b. Acacia: 0.5 g acacia (gum arabic) (British Drug Houses Ltd.) in 100 ml demineralized water.

2. *Mixed reagent I*: add successively with a graduated cylinder and mix after each addition:

- 100 ml of H_2SO_4 1.0 mol/l
- 30 ml of an aqueous ammonium molybdate solution ($(NH_4)_6Mo_7O_{24}\cdot 4H_2O$ 40 g/l)
- 10 ml of an aqueous potassium antimonyl tartrate solution (K-Sb-tartrate 2.74 g/l).

3. *Diluted mixed reagent I*: 60 ml of the mixed reagent I with 250 ml of water and 0.5 ml Aerosol, or 5 ml acacia solution.

4. *Reagent II*: 0.6 g ascorbic acid in 100 ml demineralized water (prepare fresh daily).

Table 1. Comparison of different digestion procedures for the determination of N and P in soils.

	Type of digestion			
	Proposed method		Kjeldahl procedure	conc. H_2SO_4 + conc. HNO_3 (1:1)
	N*	P*	N*	P*
1. löss soil	48	51	43	51
2. river basin clay	231	78	221	78
3. loam soil	91	44	87	46
4. peat soil	368	42	319	42
5. marine clay	103	39	97	40
6. sandy soil	107	22	117	22
7. marine clay	120	69	115	71
8. peat soil	1187	131	1221	134
9. sandy soil	91	61	90	61
10. river clay	141	285	130	252
11. sandy soil	115	74	118	85
12. sandy soil	61	113	56	126
13. sandy soil	185	88	164	100
14. river clay	80	46	77	56
15. sandy soil	90	61	90	59
16. old arable soil	250	66	240	63
17. river clay	130	123	130	120
18. humic sandy soil	460	54	480	50
19. marine clay	200	95	190	100
20. sandy soil	190	55	180	52
21. marine clay	320	117	320	114

* Data expressed in mg per 100 g oven-dry soil.

Procedure. Add to 1 ml of the digest 3 ml of the diluted mixed reagent I and 1 ml of reagent II. Mix after each addition and measure the absorbance after 1 hour at 880 nm. The colour is stable for at least 10 hours.

Discussion. For a number of different soils the results of the determination of 'total' N and 'total' P with the proposed procedure were compared with the separate digestion procedures (as mentioned earlier). The values obtained in the single digest agreed well with those obtained by the standard methods (see Table 1).

In practice we use Aerosol 22, because it is available as a solution.

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This synopsis is based on internal analytical methods used in the Department of Soil Science and Plant Nutrition. A copy of the detailed method 'Determination of 'total' N and 'total' P in soils' is available free as a paper copy from: Dept. of Soil Science and Plant Nutrition, Agricultural University, De Dreyen 3, 6703 BC Wageningen, Netherlands.

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Competition between a maize crop and a natural population of *Echinochloa crus-galli* (L.) P.B.

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Abstract. In a field exeriment, competition between a maize crop and a naturally established weed population, dominated by *Echinochloa crus-galli* (L.) P.B. (barn-