Determination of Nitrates in Soil Extracts

The phenoldisulfonic acid method has been used extensively for the determination of nitrates in soil extracts, but is somewhat inconvenient and subject to chloride interference in some extracts. The publication of a number of recent papers on alternative methods of quantitating soil nitrates indicates the need for a rapid and reliable procedure to replace the phenoldisulfonic acid method.

The possibilities of the nitrate specific ion electrode have been investigated by a number of workers, but this technique appears to be subject to some interference from inorganic anions, such as SO\text{4}^{2-}, \text{H}_2\text{PO}_4^{-}, \text{Cl}^{-}, \text{HCO}_3^{-}, \text{and NO}_2^{-}, organic anions, and dispersed colloidal material (Mack and Sanderson, 1970; Milham et al., 1970; Onkin and Sunderman, 1970). Problems with precision have been encountered (Mack and Sanderson, 1971) particularly with low NO\text{3}-N concentration (0-10 ppm).

Recently, colorimetric methods utilizing chromotropic acid (CTA) have been applied to soil extracts (Basargin and Chernova, 1968; Clarke and Jennings, 1965; Sims and Jackson, 1971). We have employed the method of Sims and Jackson, and found it rapid and sensitive; however, reproducibility and linearity were not satisfactory. Further, these methods, which include the chloride ion to increase sensitivity of the colored complex, are subject to potential interference from nitrite ion, iron, certain organic compounds, and high concentrations of Na\text{+} and K\text{+} (Basargin and Chernova, 1968; Clarke and Jennings, 1965; Sims and Jackson, 1971).

However, the most recent studies appear to have overlooked the possibilities of a CTA procedure developed by West and Ramachandran (1966) for nitrate analysis of water samples. These authors made a thorough study of the nitrate-CTA reaction and developed a procedure in which chloride was excluded and interferences due to nitrite, oxidizing agents, and many other cations and anions common in soil extracts and extracting solutions were overcome. This procedure of West and Ramachandran was tested on soil extracts in our laboratory with only minor modifications and was found to be rapid and reproducible in the 0-10 ppm range. The minor modifications introduced were as follows: the reaction vessel was a test tube rather than a 10-ml volumetric flask, and final volumes were reproduced by making standard volume additions of each solution with a rapid delivery pipette. Stirring was done using a glass rod flattened at the bottom. The reagents were the same as employed by West and Ramachandran, although purified CTA is now available commercially.

The absorption maximum at 410\text{nm} was confirmed on a Spectronic 20 spectrophotometer and the complex was stable from 20 min to 27 hours. It was not as stable and absorbance readings, particularly in the presence of daylight, were recommended that color readings be taken within about 3 hours of color development.

When the modified procedure was applied to four soils containing a range of 0.4- to 30.0-ppm NO\text{3}-N results were in good agreement with those from the phenoldisulfonic acid method and precision (coefficients of variation were 2.2\% for the phenoldisulfonic acid and CTA methods. The authors have concluded that the procedure of West and Ramachandran provides a satisfactory alternative to the phenoldisulfonic acid procedure for the determination of nitrate in soil extracts, but with improved sensitivity and speed. It can be applied to a variety of extracting agents provided the soil extract is sufficiently free of colored material. Furthermore, the procedure may well prove suitable for adaptation for automated analysis.

Literature Cited


Received May 18, 1972.

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