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Fertilizers and soil conditioners — Determination of monosilicic acid concentrations in nonliquid fertilizer materials

Détermination des concentrations en silicium soluble dans les matières fertilisantes non liquides

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 134, *Fertilizers, soil conditioners and beneficial substances*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

Although silicon is ubiquitous in nature, making up a quarter of the earth's crust[3], not all forms of silicon found in soils or fertilizer products are soluble and plant-available[4],[5]. The form of silicon in soils that is soluble and available for plant uptake is monosilicic acid. Worldwide, it has been estimated that annual removal of silicon from soils during crop production can amount to 239-255 mega tons annually, based on FAO 1998 global crop production estimates, and a conservative annual increase of 1 % through 2012. Although the first US patent on a solid Si fertilizer was issued in 1881[6], fertilizer manufacturers, governmental regulators and consumers had no means of evaluating nonliquid silicon fertilizer materials for their monosilicic acid supplying capacity to meet and replace plant uptake needs.

The first research into the use of silicon fertilizers was reported in 1840[7]. Additionally, increased plant silicon concentrations were first associated with reductions in rice (*Oryza sativa* L.) blast disease (*Magnaporthe grisea* M.E. Barr) over a century ago in Japan[8]. Since then, research has extended to other grasses and grains (e.g. barley (*Hordeum vulgare L.*)[9], corn (*Zea mays* L.)[10], oats (*Avena sativa* L.)[11], wheat (*Triticum aestivum* L.)[12], sugar cane (*Saccharum officinarum* L.)[13], pasture[14], turf grasses[15], and to dicotyledonous crops (e.g. cucumber (*Cucumis sativus* L.)[16], grapes (*Vitis vinifera* L.)[17], pepper (*Capsicum* L.)[18], pumpkin (*Curcubita pepo* L.)[19], soybean (*Glycine max* (L.) Merr.)[20], tomato (*Solanum lycopersicum* L.)[21]. Beneficial effects from silicon fertility have included increased stress tolerance (disease, insect, drought, salt, nutrient imbalance, UV-rays, low and high temperature) and yield increases with or without stress[4]. Other benefits from silicon supplements to soils have included CO_2 sequestration[22], reductions in metals toxicity[23], and reduced phosphorus run-off while increasing phosphorus use efficiency[24].

Considering the extensive research, a growing market, and the potential benefits from silicon fertility to global agriculture; it is important that a standard method exists to enable regulation of nonliquid silicon fertilizer materials based on their monosilicic acid supplying capacity. This is the first method developed which correlates well with plant silicon uptake while using commonly available laboratory equipment at a reasonable cost for the analysis. Reference the peer reviewed published version, single lab validated AOAC method[25].

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Fertilizers and soil conditioners — Determination of monosilicic acid concentrations in nonliquid fertilizer materials

1 Scope

This document establishes a method for the determination of monosilicic acid concentrations in nonliquid fertilizer materials. Monosilicic acid is reported as silicon (Si).

This extraction method is applicable to the detection of monosilicic acid in nonliquid fertilizer products, blended products, and beneficial substances at silicon (Si) concentrations of 2 to 84 g/kg, with a limit of detection (LOD) of 0,6 g/kg Si, and a limit of quantification (LOQ) of 2 g/kg correlating well with plant uptake.

This method is not applicable to liquid silicon fertilizer sources due to an expected low bias of Si recovery and low correlation with plant uptake.

2 Normative References

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 8157, *Fertilizers and soil conditioners — Vocabulary*

3 Terms and Definitions

For the purposes of this document, the terms and definitions given in ISO 8157 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
monosilicic acid
inorganic molecule that is soluble in soil solution and is the form of silicon available for plant uptake

4 Principle

Monosilicic acid (reported as Si) from nonliquid Si fertilizer sources is extracted at ambient room temperature using a dilute Na_2CO_3-NH_4NO_3 extractant. The extractant solution is analysed by manual spectrophotometry at 660 nm using the heteropoly blue method[26].

5 Safety

General requirements: A minimum of standard laboratory personal protective equipment including safety glasses, gloves, and lab coats should be worn always. Consult individual SDS for chemicals listed and follow safety and handling conditions per individual SDS instructions.

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