

# Continuing Assessment of the 5-Day Sodium Carbonate- Ammonium Nitrate Extraction Assay as an Indicator Test for Silicon Fertilizers

Silicon (Si) is the second most-abundant element in the lithosphere, and it has the ability to accumulate in many grass species, and dicotyledonous plants. Few studies have attempted to analyze the regulation of both the acquisition and accumulation of Si within plants, making the task of chemically determining the plant available source of Si (silicic acid [H<sub>4</sub>SiO<sub>4</sub>]) from a potential Si source challenging. The 5-day sodium carbonate-ammonium nitrate extraction assay has been recognized by the American Association of Plant Food Control Officials (AAPFCO) as a validated test method to identify plant-available silicon (Si). The test method used the molybdenum blue colorimetric assay to quantify percentage Si. Additionally, laboratories may use inductively coupled plasma optical emission spectroscopy (ICP-OES) for elemental analysis. The purpose of the study was to examine the use of either colorimetric or ICP-OES methods for Si determination.

The 5-day colorimetric method and a grow out study were performed using the following Si-containing compounds; wollastonite, sand, biochar, and a basic oven furnace (BOF) slag. For the 5-day methods, materials were ground with a mortar and pestle. Sodium carbonate and ammonium nitrate were added to each test material in a polypropylene flask and agitated for one hour then left undisturbed for 5 days at room temperature. The clarified top portion of the solutions was carefully transferred to a falcon tube. The extracts were diluted in a polypropylene flask and mixed. The molybdenum blue colorimetric analysis was performed on the solutions within 24 h. ICP-OES was performed on the same extract as used for the colorimetric assay to quantify total Si. *Zinnia elegans* were used as

the crop in the grow out study. Plants were grown in soil-less substrate containing the silicon amendments at three varying rates. Three weeks after transplant, leaf and root tissue were collected, dried, ground, and digested for total Si analysis via ICP-OES.

Our results show using the 5-day method, wollastonite had the highest extracted amounts of H<sub>4</sub>SiO<sub>4</sub> followed by biochar, BOF slag, and sand at 4%; 2%; 1% and 0%, respectively. Extraction values calculated using colorimetric assay or ICP-OES for detection of the H<sub>4</sub>SiO<sub>4</sub> had a significant correlation, supporting the application of either detection method for this type of analysis (Figure 1). However, when extracted values were compared to amounts of Si taken up by the plants, the 5-day method overestimated both wollastonite and biochar (Figure 2). While this method is a valid indicator test for determining a soluble Si source, other plant species and extraction methods should be perused to develop more accurate quantitative analyses for the detection and labeling of total plant-available Si from a variety of silicon-containing materials.

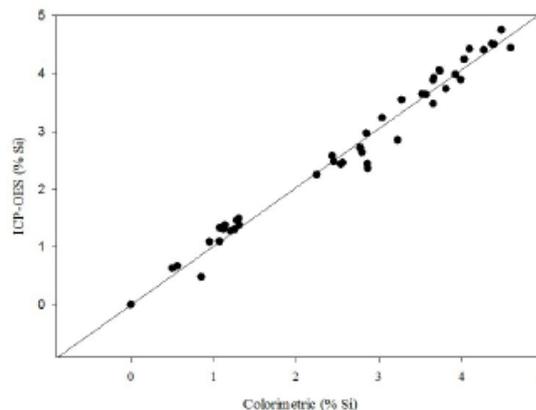


Figure 1. Scatterplot of % Si of fertilizer detected by ICP-OES versus molybdenum blue colorimetric analysis.

Figure 2. The relationship between 5-day extraction values and zinnia grow-out data. The predicted-available Si was calculated and plotted against the total Si uptake in zinnia from all amendments (A), or biochar (B), BOF slag (C), and wollastonite (D) independently.

