

Detection, Distribution, and Quantification of Silicon in Floricultural Crops Utilizing Three Distinct Analytical Methods

Silicon (Si) is not considered to be an essential plant nutrient because most plant species can complete their life cycle without its presence. However, some plant species can accumulate Si at concentrations higher than many essential macronutrients. Many studies have shown a positive growth effect if Si is present, including increased dry mass and yield, enhanced pollination, and most commonly, increased disease resistance.

Several methods for detection and quantifying Si in plants have been reported including electron beam analysis (EBA), colorimetric determination of Si after autoclave-induced digestion, and inductively coupled plasma-optical emission spectroscopy (ICP-OES). Because of the different scales of analysis, it is not known how detection with one technique (EBA) would relate to quantification by another technique (ICP-OES or colorimetric techniques). In this study we report the correlations between Si detection with EBA and two different quantification methods (ICP-OES and colorimetric). We also report simplifications in using these techniques so that there are fewer steps needed for the EBA, less caustic chemicals in the tissue digestion, and less damage to vessels and ICP-OES components.

Among the different species of plants tested there was good correlation among detection methods (Table 1). There is noticeable damage to the torch when NaOH is used instead of KOH (Figure 1A to 1D). This translated to a more cost-effective analysis with KOH digestion instead of NaOH.

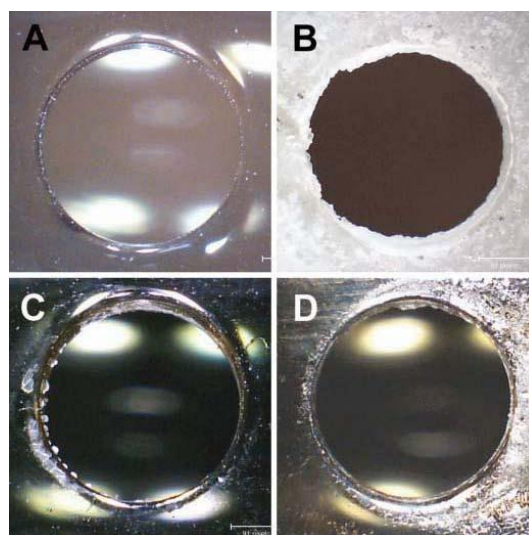


Figure 1. Radial view hole from a clean, unused ICP-OES torch (A). Radial hole from an ICP-OES torch after running about 50 samples with NaOH-digested plant tissue for Si analysis, cleaned with aqua regia and sonicated 3 h (B). Radial hole from an ICP-OES torch after running 90 samples with KOH-digested plant tissue for Si analysis (C). Radial hole from the same torch as in C after running 570 samples with KOH-digested plant tissue for Si analysis, cleaned with aqua regia and sonicated for 3 h (D).


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Table 1. Si detection, distribution, and contribution in mature leaves using EBA, ICP-OES, and Colorimetric methods.

Plant	EBA		ICP-OES		Colorimetric	
	Si Detected	Location	Leaf Si content + Si (mg kg ⁻¹)	Leaf Si content control (mg kg ⁻¹)	Leaf Si content + Si (mg kg ⁻¹)	Leaf Si content control (mg kg ⁻¹)
Geranium	No	N/A	539.1 (one sample)	range: nd to 32.0	465.3 (one sample)	199.9 ± 93.8
Dianthus	Yes	Throughout leaves	362.0 ± 94.0	nd	286.9 ± 134.9	58.6 ± 26.0
Marigold	Yes	Throughout leaves	330.4 ± 39.4	range: nd to 20.3	486.0 ± 185.5	178.5 ± 94.6
Zinnia	Yes	Leaf trichomes	12,682.7 ± 615.0	nd	11,749.7 ± 1274.9	31.02 ± 35.8
Snapdragon	No	N/A	501.6 ± 67.5	nd	258.5 ± 149.1	nd
Begonia	Yes	Leaf trichomes	649.2 ± 128.0	191.9 ± 112.9	472.2 ± 83.6	265.4 ± 194.6
Verbena	Yes	Leaf trichomes & margins	8417.0 (one sample)	137.7 (one sample)	8225.5 ± 2080.1	160.3 ± 103.2
Vinca	Yes	Leaf trichomes	330.82 ± 36.32	93.12 ± 57.66	341.2 ± 113.7	72.38 ± 37.3
Impatiens	Yes	Leaf margins	2008.23 ± 131.29	79.82 ± 52.16	923.7 ± 70.4	180.5 ± 85.7
New Guinea impatiens	Yes	Leaf trichomes & margins	2314.3 ± 255.0	141.7 ± 40.6	1457.9 ± 298.3	221.0 ± 111.9
Poinsettia	Yes	Leaf surface	465.8 ± 213.5	nd	941.1 ± 667.6	299.9 ± 179.4
Petunia	No	N/A	197.3 ± 11.6	nd	237.8 ± 17.9	nd
Calibrachoa	Yes	Leaf trichomes	1536.48 ± 50.11	129.94 ± 17.28	1338.5 ± 166.1	241.2 ± 123.8
Salvia	No	N/A	529.7 ± 97.8	range: nd to 41.1	358.9 ± 94.9	246.1 ± 171.8

Notes. Average values are shown, plus or minus one standard deviation. When at least one of the replicates had nondetectable concentrations (nd), only a range is shown. When all three replicates were nd, only nd is shown. All plants were replicated three times except the +Si geranium (n = 1) and both ± Si marigold (n = 6).