Table 1. ICP-OES operating parameters.

Method parameter	
Plasma Power (W)	1500
Gas flow (L/min)	
-*Coolant*	13
-*Auxiliary*	0.80
Nebulizer type	Cross flow
Nebulizer flow rate (L/min)	0.95
Pump speed	30
Stabilization time (s)	0
Number of probes for each measuring	3
Plasma observation	axial

Table S2. Calibration parameters for ICP-OES analysis

Element	Detection wavelength (nm)	Correlation coefficient (R^2)	Limit of detection (µg/L)	Linearity range (mg/L)	Standard error (mg/L)
B	182.641	0.99999	6.43	7.37×10^{-3}–12.0	1.44×10^{-02}
	249.773	0.99999		6.43×10^{-3}–12.0	1.60×10^{-02}
Ba	233.527	0.99998	1.15×10^{-4}	1.15×10^{-4}–12.0	1.94×10^{-02}
Bi	190.241	0.99991	3.53×10^{-3}	3.53×10^{-3}–12.0	4.75×10^{-02}
	223.061	0.99996	3.68×10^{-3}	3.68×10^{-3}–12.0	3.01×10^{-02}
Ca	183.801	0.99995	2.14	1.60–480	2.55×10^{-01}
	396.847	0.99946		2.14×10^{-3}–2.41	2.31×10^{-02}
In	325.609	1.00000	4.00×10^{-3}	4.00×10^{-3}–12.0	9.34×10^{-03}
K	404.721	0.99998	0.378	0.798–300	1.40×10^{-01}
	766.491	0.99999		3.78×10^{-4}–1.20	1.46×10^{-03}
Li	323.261	1.00000	5.75×10^{-2}	7.98×10^{-2}–12.0	8.69×10^{-03}
	670.780	0.99997		5.75×10^{-5}–1.20	3.08×10^{-03}
Mg	279.553	0.99997	0.115	1.15×10^{-4}–6.04	7.45×10^{-04}
	285.213	0.99994		4.03–120	1.54×10^{-01}
Na	330.237	0.99994	4.75	7.98–480	3.44×10^{-02}
	598.592	0.99989		4.75×10^{-3}–12.0	5.83×10^{-03}
P	214.914	0.99992	3.50×10^{-3}	3.50×10^{-3}–240	9.80×10^{-01}
Sr	407.771	0.99998	6.23×10^{-3}	6.23×10^{-6}–2.41	4.28×10^{-03}
Zn	213.856	0.99997	8.20×10^{-2}	8.20×10^{-5}–12.0	2.55×10^{-02}

Table S3. Calibration parameters for ICP-MS analysis. Calibration standards concentrations for all elements ranged between 0.500 μg/L to 100 μg/L

Element	Limit of detection (μg/L)	Correlation coefficient (R^2)	Calibration curve parameters
Ag	3.97×10^{-02}	0.9999	$y = 1.02 \times 10^{+04}.x + 1.76 \times 10^{+03}$
Al	1.23×10^{-01}	0.9997	$y = 2.64 \times 10^{+04}.x + 4.34 \times 10^{+04}$
As	3.81×10^{-02}	0.9999	$y = 2.21 \times 10^{+03}.x + 4.91 \times 10^{+01}$
Be	1.74×10^{-03}	1.0000	$y = 8.26 \times 10^{+03}.x + 2.98 \times 10^{+00}$
Cd	4.40×10^{-03}	0.9999	$y = 2.15 \times 10^{+03}.x + 9.98 \times 10^{-01}$
Ce	2.37×10^{-03}	0.9996	$y = 2.90 \times 10^{+04}.x + 5.00 \times 10^{+01}$
Co	9.87×10^{-03}	0.9998	$y = 1.92 \times 10^{+04}.x + 4.97 \times 10^{+02}$
Cr	8.35×10^{-02}	0.9998	$y = 2.12 \times 10^{+04}.x + 4.31 \times 10^{+04}$
Cu	5.70×10^{-02}	0.9996	$y = 3.80 \times 10^{+03}.x + 3.36 \times 10^{+02}$
Fe	$3.22 \times 10^{+00}$	0.9992	$y = 5.64 \times 10^{+02}.x + 1.65 \times 10^{+04}$
Mn	1.38×10^{-02}	0.9999	$y = 3.01 \times 10^{+04}.x + 5.00 \times 10^{+03}$
Mo	6.46×10^{-02}	0.9999	$y = 7.09 \times 10^{+03}.x + 1.50 \times 10^{+03}$
Ni	1.74×10^{-01}	1.0000	$y = 3.74 \times 10^{+03}.x + 4.51 \times 10^{+03}$
Pb	7.09×10^{-03}	0.9994	$y = 9.19 \times 10^{+03}.x + 6.60 \times 10^{+01}$
Rb	1.56×10^{-03}	0.9995	$y = 2.00 \times 10^{+04}.x + 1.20 \times 10^{+01}$
Sb	3.44×10^{-03}	0.9997	$y = 6.09 \times 10 \times^{+03}.x + 9.05 \times 10^{+00}$
Se	2.32×10^{-01}	0.9993	$y = 2.19 \times 10^{+02}.x + 6.03 \times 10^{-01}$
Sn	5.35×10^{-03}	0.9998	$y = 5.85 \times 10^{+03}.x + 2.61 \times 10^{+01}$
Sr	2.60×10^{-02}	0.9996	$y = 2.68 \times 10^{+04}.x + 1.31 \times 10^{+03}$
Tl	1.27×10^{-03}	0.9999	$y = 1.33 \times 10^{+04}.x + 4.01 \times 10^{+00}$
U	4.86×10^{-04}	0.9999	$y = 2.07 \times 10^{+04}.x + 2.03 \times 10^{+00}$
V	1.47×10^{-02}	0.9997	$y = 2.32 \times 10^{+04}.x + 2.38 \times 10^{+03}$

Table S4- Bioavailable chemical forms of the elements to plants; functions in plant metabolism; presence in specific organs or molecules in plants and its potentially toxic effects due to element deficiency and/or excess

Element	Bioavailable chemical form	Functions in plants	Presence in plants	Toxicity effects
		Main macronutrients		
N	NH^{4+}; NO_3^-	The main limiting factor in plant production. Organic N found as high-molecular-weight proteins in plants; Combines with C, H, O, and sometimes S, to form amino acids, amino enzymes, nucleic acids, chlorophyll, alkaloids, and purine bases	Present in the entire plant but mainly on the leaves. Inorganic N can accumulate in the plant in the nitrate (NO_3^-) form.	Critical values vary considerably, depending on plant species, stage of growth, and plant part. Excess N turns leaves tissues prone to insect and fungi attacks and also vulnerable to harsh climacteric conditions.
P	$H_2PO_4^-$; HPO_4^{2-}	Present in some enzymes and proteins, adenosine triphosphate (ATP), NADPH, ribonucleic acids (RNA), deoxyribonucleic acids (DNA), phospholipids and phytin. ATP is involved in various energy transfer reactions, and RNA and DNA are components of genetic information.	Present in the structure of protoplasm and phytin that is the main form that P is stocked in seeds (phytin allows the germination and feeding of young plants).	There is no toxicity reported for an excess of P, but deficiency of this element provokes the same damage in plants as N excess.
K	K^+	Involved in the maintenance of the water status of the plant, the turgor pressure of its cells, and the opening and closing of its stomata. Necessary for the accumulation and translocation of newly formed carbohydrates. K stays in its mineral form in plants and is essential in the metabolism of N and protein synthesis.	Present in the cells as K^+ in all plant tissues	The deficiency of K in plants provokes chlorotic and necrotic damage on the tissues. Excess K is not toxic to plants but can hinder the absorption of other cations like Ca and Mg.
		Secondary macronutrients		
Ca	Ca^{2+}	Maintenance of cell integrity and membrane permeability; enhancement of pollen germination and growth. Activation of enzymes for cell mitosis, division, and elongation. May be involved in protein synthesis and carbohydrate transfer. May serve to detoxify the presence of heavy metals in the plant.	Present in the cells as Ca^{2+} in all plant tissues	Deficiency of Ca provokes atrophy in young plant growth

Mg	Mg^{2+}	A component of the chlorophyll molecule Serves as a cofactor in most enzymes that activate phosphorylation processes as a bridge between pyrophosphate structures of ATP or ADP and the enzyme molecule. Stabilizes the ribosome particles in the configuration for protein synthesis.	Main mineral component of chlorophyll.	Deficiency of Mg in plants provokes chlorotic and necrotic damage on leaves and other tissues:
S	SO_4^{2-}	Involved in protein synthesis and in the formation of the amino acids cystine and thiamine. Present in peptide glutathione, coenzyme A, and vitamin B1, and in glucosides such as mustard oil and thiols. It can reduce the incidence of disease in many plants.	Necessary for chlorophyll formation and is present in several volatile compounds responsible for the typical aroma of onions and mustard.	The deficiency of S in plants provokes chlorotic damage in the entire plant.
		Micronutrients		
B	BO_3^{3-}	Believed to be important in the synthesis of one of the bases for RNA (uracil) formation. Involved in cellular activities (e.g., division, differentiation, maturation, respiration, growth, and others). Has long been associated with pollen germination and growth, improving the stability of pollen tubes. Relatively immobile in plants. Transported primarily in the xylem.	Phosphogluconates	The toxicity level is 100 ppm; Margin or leaf tip chlorosis, browning of leaf points, decaying growing points, and wilting and dying-off of older leaves.
Cl	Cl^-	Involved in the evolution of oxygen (O_2) in photosystem II in the photosynthesis process. Raises the cell osmotic pressure. Affects stomatal regulation. Increases the hydration of plant tissue. May be related to the suppression of leaf spot disease in wheat and fungus root disease in oat. Neutralization of cations.	Present in all plant tissues	Toxicity levels not reported because Cl is not considered toxic for plants even for high concentrations of this element, but for sensitive plants deficiency of Cl can be seen chlorosis of younger leaves and wilting of the plant. Excess Cl provokes damage in the leaves and is associated with soils rich in NaCl.

Cu	Cu^{2+}	Serves as a part of the electron transport system linking photosystems I and II in the photosynthesis process. Participates in protein and carbohydrate metabolism and nitrogen (N_2) fixation. Part of the enzymes that reduce both atoms of molecular oxygen (O_2) (cytochrome oxidase, ascorbic acid oxidase, and polyphenol oxidase). It is involved in the desaturation and hydroxylation of fatty acids. Cu controls the production of DNA and RNA, and its deficiency significantly inhibits the reproduction of plants (reduced seed production, pollen sterility). Cu is involved in the mechanisms of disease resistance and fungal attacks.	A constituent of the chloroplast, protein, plastocyanin, various oxidases, and ceniloplasmin	The toxicity level is 20 to 30 ppm, but higher values, 20 to 200 ppm, can be tolerated if Cu has been applied as a fungicide. Dark green leaves followed by induced Fe chlorosis, thick, short, or barbed-wire roots. Changes in lipid content and losses of polypeptides involved in photochemical activities.
Fe	Fe^{2+}; Fe^{3+}	Component in many plant enzyme systems, such as cytochrome oxidase (electron transport) and cytochrome (terminal respiration step), in protein ferredoxin and is required for NO_3^- and SO_4^{2-} reduction, nitrogen (N_2) assimilation, and energy (NADP) production; functions as a catalyst or part of an enzyme system associated with chlorophyll formation. May be involved in protein synthesis and root-tip meristem growth.	Hemo-proteins and non-heme iron proteins, dehydrogenases, and ferrodoxins	Toxicity not clearly defined; Dark green foliage, stunted growth of tops and roots, dark brown to purple leaves of some plants (e.g., "bronzing" disease of rice).
Mn	Mn^{2+}	Involved in oxidation-reduction processes in the photosynthetic electron transport system. Essential in photosystem II for photolysis, acts as a bridge for ATP and enzyme complex phosphokinase and phosphotransferases, and activates IAA oxidases.	Many enzyme systems	Not known to interfere with the metabolism or uptake of any of the other essential elements. Chlorosis and necrotic lesions on old leaves, blackish-brown or red necrotic spots, accumulation of MnO_2 particles in epidermal cells, drying tips of leaves, and stunted roots and plant growth
Mo	MoO_4^{2-}	Is a component of two major enzyme systems, nitrogenase and nitrate reductase, nitrogenase being involved in the conversion of nitrate (NO_3^-) to ammonium (NH_4^+). The requirement for Mo is reduced greatly if the primary form of nitrogen (N) available to the plant is NH^{4+}.	Nitrate reductase, nitrogenase, oxidases, and molybdoferredoxin	Toxicity levels of 5 ppm or more; Yellowing or browning of leaves, depressed root growth, depressed tillering.

Ni	Ni^{2+}	Component of plant urease. Benefits growth of N-fixing plant species. Nickel is a component of the enzyme urease.	Enzyme urease (in Canavalia seeds)	10 ppm for Ni-sensitive plants and up to 50 ppm for Ni-tolerant plants; Interveinal chlorosis (caused by Fe-induced deficiency) in new leaves, gray-green leaves, and brown and stunted roots and plant growth. Plants deficient in Ni have high levels of urea in their leaves and grow slowly.
Zn	hydrated Zn and Zn^{2+}	Involved in the same enzymatic functions as Mn and Mg and activates carbonic anhydrase. Suggested that P can interfere with Zn metabolism as well as affect the uptake of Zn through the root.	Anhydrases, dehydrogenases, proteinases, and peptidases	High Zn can induce a Fe deficiency, particularly in those plants sensitive to Fe. Chlorotic and necrotic leaf tips, interveinal chlorosis in new leaves, retarded growth of the entire plant, and injured roots.
		Beneficial nutrients		
Ag	$AgNO_3$; Ag_2S is deposited in root tissues and excluded from metabolic processes.	Induces production of male flowers on female plants; blocks the production of ethylene; cut flower life can be enhanced by pretreatment with Ag compounds	Ag ions have a high affinity for binding sulfhydryl groups of some organic compounds.	$AgNO_3$ can be quickly taken up by plants and is toxic in relatively low concentrations (<8.5 μM/L). $AgNO_3$ is reported to be the most toxic compound to terrestrial plants.
As	AsO^{2-}, AsO_4^{3-}, $HAsO_4^{2-}$, H_2AsO^{3-}	Metabolism of carbohydrates in algae and fungi; As is a constituent of most plants, but little is known about its biochemical role.	Phospholipid (in algae)	In general, the residue tolerance for As in plants is established as 2 ppm DW. Red-brown necrotic spots on old leaves, yellowing or browning of roots, depressed tillering, wilting of new leaves. As is a metabolic inhibitor, therefore, yield reduction of vegetation under a high level of bioavailable As should be expected.
Ba	Ba^{2+}	Although Ba is reported to be commonly present in plants, it apparently is not an essential component of plant tissues.	Ba is present in leaves of cereal and legumes	Possible toxicity of Ba to plants may be significantly reduced by the addition of Ca, Mg, and S salts to the growth medium. Antagonistic interactions between these elements and Ba may occur in both plant tissues and soils.

Bi	$Bi_2O_2CO_3$	The Bi content of plants has not been studied extensively, and its metabolic effect is not known.	Present in the edible parts of plants	Bi is likely to be concentrated at polluted sites due to its high concentration in some coals and sewage sludges. Toxicity not reported.
Cd	Cd^{2+}	The most critical biochemical characteristic of Cd ions is their strong affinity for sulfhydryl groups of several compounds. Besides, Cd also shows an affinity for other side chains of protein and phosphate groups. This fact is crucial in food production problems. It was reported that Cd specifically induced cysteine and methionine synthesis in soybeans, depending on the degree of plant resistance to increased Cd levels.	Present in the root and leaf systems. Cd is likely to be concentrated in the protein fractions of plants.	Elevated Cd contents of plants are growth retardation, brown margin of leaves, chlorosis, reddish veins and petioles, curled leaves, and brown stunted roots. The phytotoxicity of Cd, beyond interfering with the normal metabolism of some micronutrients, shows inhibitory effects on photosynthesis, disturbs transpiration and CO_2 fixation, and alters the permeability of cell membranes. Phytotoxic concentrations of Cd to be 5 to 10 ppm (DW) in the sensitive plant.
Co	Co^{2+}	Accelerates pollen germination; elevates the protein content of legumes; contributes to the maximum occupation of the leaf surface by chloroplasts and pigments; symbiotic N2-fixation by legumes. Cobalt is required indirectly by leguminous plants because this element is essential for the Rhizobium bacteria, which live symbiotically in the roots, fixing atmospheric an inorganic source of N existent as ions (either NO_3^- and/or NH_4^+) in the soil solution.	Cobamide coenzyme, plant roots	Interveinal chlorosis in new leaves followed by induced Fe chlorosis and white leaf margins and tips, and damaged root tips.
Cr	Cr^{6+}	There is no evidence yet of an essential role of Cr in plant metabolism, although some positive effects on plant growth of Cr applications to soils having a low soluble Cr the content was reported. The Cr content in plants is controlled mainly by the soluble Cr content of the soils.	Leaves and roots of plants	Chlorosis of new leaves, necrotic spots, and purpling tissues, injured root growth of Cr has been often reported, especially in plants on soils developed from ultrabasic rocks. Phytotoxicity levels range between 5 to 60 ppm in culture soils.
I	I^-, IO^{3-}	Stimulates growth of plants in I-deficient soils; stimulates the synthesis of cellulose and lignification of stem tissue; increases concentration of ascorbic acid; seems to increase the salt tolerance of plants by lowering Cl uptake	Tyrosine and its derivatives (in angiosperms and algae)	Margin and leaf tip necrosis, and chlorotic and red-brown points of leaves

In	In^{+}	Is very available to plants, although not significantly concentrated in plants	Present in the foliage of plants	Induces toxicity in roots
Li	Li^{+}	Some plants can accumulate Li to high concentrations; may affect the transport of sugars from leaves to roots in sugar beets; increases chlorophyll content of potato and pepper plants	Located mainly in leaf tissues	Chlorotic and necrotic spots on leaves and injured root growth. Toxic to citrus trees at concentrations higher than 140 ppm.
Na	Na^{+}	Helps maintain cell turgidity and photosynthetic efficiency	Accumulates in vacuoles	It can be a replacement for K in some plants, Na is an element that can be beneficial at low concentrations and detrimental at high concentrations. Increases osmotic pressure.
Pb	$Pb_2P_2O_7$	Although there is no evidence that Pb is essential for the growth of any plant species, there are many reports on the stimulating effects on plant growth of some Pb salts (mainly $Pb(NO_3)_2$) at low concentrations.	Usually present in root tissues as $Pb_2P_2O_7$ deposits.	Several reports describe the toxic effects of Pb on processes such as photosynthesis, mitosis, and water absorption; however, the toxic symptoms in plants are not very specific. Dark green leaves, wilting of older leaves, stunted foliage, and short brown roots.
Rb	Rb^{+}	May partially substitute for K, when P and NH_4^{+}-N are high in the plant; enhances the yield of fertile soil; may play a role in sugar beet plant by enhancing yield and sugar content.	Present in the cells of all plant tissues	It may partly substitute for K sites in plants, as their properties are similar, but cannot substitute for K metabolic roles; therefore, in high concentrations, it is slightly toxic to plants. Dark green leaves, stunted foliage, and an increasing amount of shoots
Sb	Sb^{3+}	Sb is considered a nonessential metal and is known to be quickly taken up by plants if present insoluble forms.	Present in roots and leaves	There are no reports of plant toxicity caused by Sb; however, Sb levels may be expected to increase in plants growing in soils contaminated by industrial emissions or sewage sludge applications.
Se	Se^{6+}, Se^{4+}	Stimulates growth for high Se accumulator plants; can replace S in S-amino acids in wheat; can replace S in some plants	Glycene reductase (in Clostridium cells); combined with cysteine and methionine	Interveinal chlorosis or black spots at Se content at about 4 ppm, and complete bleaching or yellowing of younger leaves at higher Se content, pinkish spots on roots
Sn	Sn^{2+}	There is no evidence that Sn is either essential or beneficial to plants, although plants may easily take up Sn, if present in the nutrient solution, but most of the absorbed Sn remains in roots.	Most Sn remains in plant roots but under natural soil conditions it is not present in all plants	Sn is very toxic to both higher plants and fungi, although no toxicity levels were reported.

Sr	Sr^{2+}	May partially replace Ca when Ca requirement is high	Present in all plant tissues	There are not many reports of Sr toxicity in plants, and plants vary in their tolerance to this element, but a level of 30 ppm was reported as toxic to plants.
Ti	Ti^{2+}	May play a role in photosynthesis and N_2-fixation; increases chlorophyll content of tomato leaves; increases yield, fruit ripening, and sugar content of fruit; may be essential for plants.	Edible parts of plants in deficient concentrations due to its low mobility and availability to plants	Chlorosis and necrosis of leaves, stunted growth
V	VO_4^{3-}, VO^{2-}, VO^{3-}, HVO_4^{2-} (depending on pH)	Complements and enhances the functioning of Mo; both V and Mo are involved in the N_2-fixation process, contribute to the initial stages of seed germination. Essential for alga species stimulating photosynthesis in these organisms.	Porphyrins, hemoproteins	Concentrations of V higher than 0.5 ppm in nutrient solutions can present toxicity to plants reducing the length of the roots.

Adapted from:

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