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Center for Smart Agriculture

Hydroponics Technology



Module 1: Prerequisites for hydroponics technology

Session 3 : Nutrient requirements, deficiencies and toxicities



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There are seventeen essential nutrients that are supplied to crops. Of these, three are available through water uptake and gas exchange (the air): Carbon through CO_2 , hydrogen, and oxygen.

Six macronutrients are N, P, K, Ca, Mg and S and others are micronutrients



Lastly added essential micronutrient is Ni and it is essential for regulating N metabolism, grain filling and seed viability.



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Role of different nutrients in plant growth

TABLE I: Form, source, mode of uptake and major functions of the 16 plant essential nutrients.

Nutrient family	Nutrient	Percentage of plant	Form taken up by plants (ion)	Mode of uptake	Major functions in plants
Primary	Carbon	45	Carbon dioxide (CO_2), bicarbonate (HCO_3^-)	Open stomates	Plant structures
	Oxygen	45	Water (H_2O)	Mass flow	Respiration, energy production, plant structures
	Hydrogen	6.0	Water (H_2O)	Mass flow	pH regulation, water retention, synthesis of carbohydrates
	Nitrogen	1.75	Nitrate (NO_3^-), ammonium (NH_4^+)	Mass flow	Protein/amino acids, chlorophyll, cell formation
	Phosphorus	0.25	Dihydrogen phosphate (H_2PO_4^-), HPO_4^{2-}), phosphate (PO_4^{3-})	Root interception	Cell formation, protein syntheses, fat and carbohydrate metabolism
	Potassium	1.5	Potassium ion (K^+)	Mass flow	Water regulation, enzyme activity
Secondary	Calcium	0.50	Calcium ion (Ca^{2+})	Mass flow	Root permeability, enzyme activity
	Magnesium	0.20	Magnesium ion (Mg^{2+})	Mass flow	Chlorophyll, fat formation and metabolism
	Sulfur	0.03	Sulfate (SO_4^{2-})	Mass flow	Protein, amino acid, vitamin and oil formation
Micro	Chlorine	0.01	Chloride (Cl^-)	Root interception	Chlorophyll formation, enzyme activity, cellular development
	Iron	0.01	Iron ion (Fe^{2+} , Fe^{3+})	Root interception	Enzyme development and activity
	Zinc	0.002	Zinc ion (Zn^{2+})	Root interception	Enzyme activity
	Manganese	0.005	Manganese ion (Mn^{2+})	Root interception	Enzyme activity and pigmentation
	Boron	0.0001	Boric acid (H_3BO_3), borate (BO_3^{3-}), tetraborate (B_4O_7)	Root interception	Enzyme activity
	Copper	0.0001	Copper ion (Cu^{2+})	Mass flow	Enzyme activity
	Molybdenum	0.00001	Molybdenum ions (HMoO_4^- , MoO_4^{2-})	Mass flow	Enzyme activity and nitrogen fixation in legumes

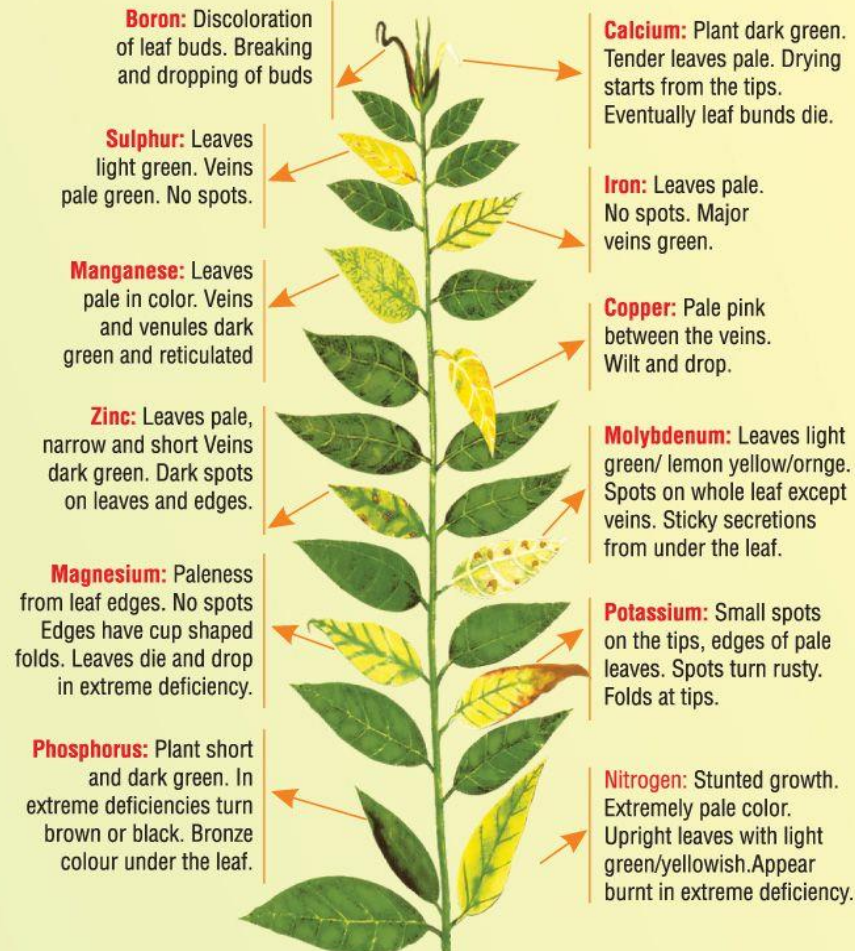


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Deficiency chart of Essential Elements

Deficiency Chart of Micronutrients



THE COLOUR REPRESENTED ARE INDICATIVE.
THEY MAY VARY FROM PLANT TO PLANT



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Nitrogen Deficiency





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Phosphorus Deficiency





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Potassium Deficiency





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Ca, Mg and S Deficiency





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Micronutrient deficiency symptoms



Chlorosis on fenugreek leaves



Interveinal chlorosis on cabbage leaves



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Mg Deficiency



Fe deficiency



Cu deficiency



B Deficiency



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Toxicity Symptoms for Essential Elements

N: Restricted root system. Potatoes form only small tubers, and flowering and seed production can be retarded.

P: Sometimes copper and zinc deficiency occurs in the presence of excess phosphorus

K: Oranges develop coarse fruit at high potassium levels. Excess potassium may lead to magnesium deficiency and possible manganese, zinc, or iron deficiency

S: Reduction in growth and leaf size. Leaf symptoms often absent or poorly defined. Sometimes interveinal yellowing or leaf burning.



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Mg: Mg: Very little information available on visual symptoms.

Ca: Usually associated with excess carbonate

Fe: It appears as necrotic spots.

Cl: Burning or firing of leaf tip or margins. Bronzing, yellowing, and leaf abscission and sometimes chlorosis. Reduced leaf size and lower growth rate



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Mn: Sometimes chlorosis, uneven chlorophyll distribution, and iron deficiency (pineapple). Reduction in growth.

Cl: Burning or firing of leaf tip or margins. Bronzing, yellowing, and leaf abscission and sometimes chlorosis. Reduced leaf size and lower growth rate

Zn: Excess zinc commonly produces iron chlorosis in plants.

Cu: Reduced growth followed by symptoms of iron chlorosis, stunting, reduced branching, thickening, and abnormal darkening of rootlets.

Mo: Leaves turn golden yellow



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Thank you...