Nitrogen (N)

Physiology - One of the most abundant elements in plants, cell division, protein synthesis, photosynthesis, carbohydrate metabolism, vitamin component

Chemisty – Plants absorb as: Nitrate (NO3-), Ammonium (NH4+), Amine (NH2-)

Biological -
-Cucumis Sativus, Cucumber / Fruit – 8%
-Vachellia Farnesiana / Needle Brush – Leaf – 6.8%
-Urtica Dioica / Stinging Nettle – Leaf - 5.5% (3% Nitrate)
-Anethum Graveolens / Garden Dill – Plant – 5.5%
-Latuca Sativa / Lettuce – Leaf – 5.4%
-Spinacia Oleracea / Spinach – Leaf – 4.5%
-Raphanus Sativus / Radish – Root – 3.8%
-Brassica Oleracea / Cabbage – Leaf – 3.7% (1% Ammonia)
-Althea Officinalis / Marshmallow – Root – 4% Betaine
-Chenopodium Album / Lamsquarter – Leaf – 1.2% Betaine
-Borago officinalis / Borage – Leaf – 3% Potassium Nitrate

Phosphorus (P)

Physiology – Essential component of ADP and ATP, thus energy storage and release for ALL biological processes. Forms genetic material and dna molecular foundation. Indispensible in all stages.

Chemistry – Plants absorb as: Dihydrogen phosphate ($H_2PO_4^-$), hydrogen phosphate (HPO_4^{-2}), or phosphorus oxide ($P_2O_{5,3}$)

Biological -
P
Beta vulgaris / Beet – Root – 4.5%
Xanthosoma saggitifolium / Malanga – Leaf – 3.8%
Chenopodium album / Lambsquarter – Leaf – 3.6%
Equisetum arvense / Horsetail – Plant – 1.4%
Momordica charantia / Bitter Melon – Fruit – 3.3%
Linum usitatissimum / Flax – Seed – 2%
Physalis ixocarpa / Tomatillo – Fruit – 3%
Cucurbita pepo / Pumpkin – Flower – 1%
P_2O_5
Dioscorea bulbifera / Air yam – Tuber – 0.8%
P_2O_3
Morus alba / White Mulberry – Leaf – 1.4%

Potassium (K)

Physiology – Dominant electrolyte in cytosol. Carbohydrate metabolism, photosynthesis, protein synthesis, fruit formation, activates enzymes and controls their reaction rates, seed/fruit quality, temperature hardiness and disease resistance

Chemistry – Plants absorb as: Potash (K^+)

Biological
Lactuca Sativa / Lettuce – Leaf – 12%
Chichorium Endivium - Endive – Leaf – 9.6%
Chenopodium Album / Lambsquarter – Leaf – 8.7%
Raphanus sativus / Radish – Root – 8.5%
Brassica RapaChinese Cabbage – Leaf – 8.1%
Amaranthus sp. / Pigweed – Leaf – 7.3%
Cucumis Sativus / Cucumber – Fruit – 7.2%
Spinacia Oleracea / Spinach – Plant – 6.9%
Borago Officinalis / Borage – Leaf – 6.7%
Nastutium Officinale / Nasturtium – Plant – 6.6%
Beta Vulgaris / Sugar Beets – Leaf – 6.2%

Sulfur (S)

Physiology – Amino acid constituent, protein synthesis, development of several enzymes and vitamins, seed production, nodule formation in legumes, chlorophyll formation

Chemistry – Plants absorb as: Sulfate (SO_4^{-2})

Biological
Brassica oleracea var. botrytis L. / Cauliflower – Leaf - 1.2%
Anethum graveolens L. / Dill, Garden Dill – Plant - 1.4%
Pastinaca sativa L. – Parsnip – Root / 1.1%
Armoracia rusticana / Horseradish – Root - 1.8%
Lepidium sativum L. / Garden Cress – Seed – 1%
Brassica oleracea var. capitata L. / Cabbage – Leaf – 0.9%
Urtica dioica L. / European Nettle, Stinging Nettle - Leaf – 0.6%
Raphanus sativus L. / Radish – Root – 0.6%
Spinacia oleracea L. / Spinach – Plant – 0.6%
Morus alba L. / Sang-Pai-Pi, White Mulberry – Leaf – 0.6%
Cucumis sativus L. / Cucumber – Fruit – 0.5%
SO_4
Echinacea spp / Coneflowe, Echinacea - Root – 0.2%
Aspalathus linearis / Rooibos – Shoot – 0.1%

Calcium (Ca)

Physiology – Cell division and wall formation, regulates access to plant cells, nitrogen metabolism, enzyme activation and cell reproduction, reduces respiration, increases fruit set, aids translocation of photosynthate and stimulates microbial activity

Chemistry – Plants absorb as: Calcium ions (Ca^{+2}), calcium chelates (Ca[R]±*)

Biological
Ca
Cucurbita foetidissima / Buffalo Gourd – Leaf - 7.7%
Lycopersicon esculentum / Tomato – Leaf – 6%
Luffa aegyptiaca / Loofa Gourd - Leaf – 5.5%
Brassica oleracea var. botrytis / Cauliflower – Leaf - 5.4%
Brassica oleracea var italica / Broccoli - Leaf - 5.4%
Lycium chinense / - Root Bark - 5.4%
Amaranthus spinosus / Pigweed – Leaf - 5.3%
CaO
Corylus avellana / Filbert, Hazel – Leaf – 3.5%
Stellaria Media / Chickweed – Plant – 1.8%

Magnesium (Mg)

Physiology – Chlorophyll constituent, enzyme activation, mobility and utilization of phosphorus, utilization of iron, influences earliness and uniformity of maturity

Chemistry – Plants absorb as: Magnesium ions (Mg^{+2}), magnesium chelates (Mg[R]±*)

Biological
Mg
Carya glabra / Pignut Hickory – Shoot- 2.4%
Carya ovata / Shagbark Hickory – Shoot - 2.1%
Chondrus crispus / Irish Moss – Plant - 1.9%
Portulaca oleracea / Purslane, Verdolaga – Plant - 1.8%
Phaseolus vulgaris subsp. var. vulgaris / Beans – Fruit - 1.8%
Avena sativa / Oats - Plant – 1.4%
Spinacia oleracea L. – Spinach - Plant – 1.1%
Glycyrrhiza glabra L. / Licorice - Root -1%
Prunus serotina subsp. serotina / Wild Black Cherry – Leaf - 1%
MgO
Stellaria Media / Chickweed – Plant – 2.8%

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Boron (B)

Physiology – Turgor pressure, vascular system constituent, water uptake and transport, photosynthate translocation, growing tissue, N fixation, protein synthesis, root growth

Chemistry – Plants absorb as: Boric acid (H_2BO_3)

Biological
Valerianella locusta L. / Corn Salad, Lamb's Lettuce – Plant – 0.035%
Prunus domestica L. / Plum – Fruit - 0.026%
Cydonia oblonga / Quince – Fruit - 0.016%
Fragaria spp / Strawberry – Fruit – 0.016%
Prunus persica L./ Peach – Fruit - 0.015%
Brassica oleracea var. capitata L. / Cabbage – Leaf - 0.015%
Taraxacum officinale / Dandelion – Leaf – 0.013%
Malus domestica / Apple – Fruit – 0.011%
Asparagus officinalis L. / Asparagus – Shoot - 0.001%;
Apium graveolens L. / Celery – Root - 0.001%

Manganese (Mn)

Physiology – Essential reduction agent, balances iron, chlorophyll synthesis, metabolism of vitamins, carbohydrates and nitrogen

Chemistry – Plants absorb as: Manganese ions (Mn^{+2}), manganese chelates (Mn[R]±*)

Biological
Quercus alba L. / White Oak – Stem – 0.3%
Carya glabra / Pignut Hickory – Shoot – 0.3%
Quercus rubra L. / Northern Red Oak – Stem – 0.3%
Juniperus virginiana L. / Red Cedar – Shoot – 0.2%
Vaccinium myrtillus L./ Bilberry – Leaf – 0.2%
Vaccinium vitis-idaea var. minus / Lingonberry – Leaf – 0.2%
Liquidambar styraciflua L. / Am. Styrax, Sweetgum – Stem – 0.2%
Quercus velutina / Black Oak – Stem - 0.2%
Diospyros virginiana L. / American Persimmon – Leaf - 0.2%
↳ Stem – 0.1%
Camellia sinensis L. / Tea – Leaf - 0.1%
Syzygium aromaticum L. / Clove, Clovetree – Flower - 0.1%
Vitis vinifera L. / Wine Grape – Stem – 0.1%

Copper (Cu)

Physiology – Reproductive growth, enzyme catalyst, chlorophyll synthesis, root metabolism, protein synthesis and use

Chemistry – Plants absorb as: Cupric (Cu^{+2}), copper chelates (Cu[R]±*)

Biological
Prunus serotina subsp. serotina / Wild Black Cherry - Stem - 0.04%
Liquidambar styraciflua L. / Am. Styrax, Sweetgum – Stem – 0.04%
↳ Leaf – 0.02%
Diospyros virginiana L. / American Persimmon – Stem - 0.01%
Sassafras albidum / Sassafras – Leaf – 0.01%
Lycopersicon esculentum / Tomato; - Fruit - 0.01%
Brassica oleracea var. capitata L. / Cabbage – Leaf – 0.008%
Sesamum indicum / Sesame – Plant – 0.005%
Brassica oleracea var. botrytis L. / Cauliflower – Leaf -0.005%

Iron (Fe)

Physiology – Essential oxidizing agent, balances manganese, nitrogen fixation, chlorophyll synthesis, enzymes, proteins, carotenoids

Chemistry – Plants absorb as: Ferrous ions (Fe^{+2}), ferric ions (Fe^{+3}), or iron chelates (Fe[R]±*)

Biological
Taraxacum officinale / Dandelion – Leaf – 0.5%
Echinacea spp / Coneflower, Echinacea - Root – 0.5%
Valerianella locusta L / Corn Salad, Lamb's Lettuce – Plant – 0.4%
Artemisia vulgaris L. / Mugwort - Plant - 0.4%
Boehmeria nivea L / Ramie – Plant – 0.4%
Physalis ixocarpa / Tomatillo - Fruit – 0.3%
Stellaria media L. / Chickweed, Common Chickweed – Plant - 0.2%
Verbascum thapsus L. / Mullein – Leaf - 0.2%,
Prunus serotina subsp. serotina / Wild Black Cherry – Leaf - 0.1%

Zinc (Zn)

Physiology – Plant growth hormone production, seed formation and maturation, component of enzymes for energy production, protein synthesis, and growth regulation

Chemistry – Plants absorb as: Zinc ions (Zn^{+2}), zinc chelates (Zn[R]±*)

Biological
Carya glabra / Pignut Hickory – Shoot – 0.1%
Lactuca sativa L. / Lettuce – Leaf – 0.1%
Aloe vera L. / Aloe, Bitter Aloes – Leaf – 0.08%
Valerianellaradicata / Beaked Cornsalad– Plant – 0.07%
Juniperus virginiana L. / Red Cedar – Shoot – 0.03%
Spinacia oleracea L. / Spinach – Plant – 0.02%
Liquidambar styraciflua L. / Am. Styrax, Sweetgum – Stem – 0.02%
Prunus serotina subsp. serotina / Wild Black Cherry- Stem - 0.02%
↳ Leaf – 0.02%

Molybdenum (Mo)

Physiology – Nitrogen metabolism and protein synthesis, inorganic to organic phosphate conversion, microbial nitrogen fixation

Chemistry – Plants absorb as: Molybdate (MoO_4^{-2}), molybdenum chelates (Mo[R]±*)

Biological
Carya glabra / Pignut Hickory – Shoot - 0.003%
Phaseolus vulgaris subsp. var. vulgaris / Beans – Fruit – 0.002%
Capsicum annuum L. / Bell Pepper– Fruit - 0.002%
Phaseolus lunatus L. / Butter Bean, Lima Bean – Seed - 0.002%
Petroselinum crispum / Parsley – Plant - 0.001%
Quercus alba L. / White Oak – Stem – 0.0009%
Brassica oleracea var. capitata l. / Cabbage – Leaf - 0.0009%
Zea mays L. / Corn – Seed - 0.0006%
Lycopersicon esculentum / Tomato – Fruit - 0.0006%

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Silicon (Si)

Physiology – Vascular system constituent, cell wall fortification, abiotic and biotic stress tolerance, alleviates heavy metal toxicity, enhances potassium, phosphorus and calcium uptake

Chemistry – Plants absorb as: Monosilicic acid ($H_4SiO_4^-$)

Biological

Si

Urtica dioica L. / European Nettle, Stinging Nettle - Leaf – 6.5%
Carya glabra / Pignut Hickory - Shoot – 4.1%
Quercus rubra L. / Northern Red Oak - Stem – 2.4%
Petroselinum crispum / Parsley - Leaf– 1.4%
Phaseolus vulgaris subsp. var. vulgaris – Beans – Fruit – 1.2%
Cucumis sativus L. / Cucumber – Fruit – 1%

SiO_2

Oryza sativa L. / Rice – Plant - 14%
Equisetum arvense L. / Field Horsetail, Horsetail – Plant – 9.7%
Tephrosia purpurea / Purple Tephrosia, Wild Indigo – Leaf - 2.1%
Pueraria montana subsp. lobata / Kudsu, Kudzu – Shoot - 1.5%
Galeopsis segetum / Downy Hemp Nettle – Shoot – 1%
Mangifera indica L. / Mango – Seed - 0.4%

H_4SiO_4

Agrimonia eupatoria L. / Agrimony, Sticklewort – Exocarp - 12%
Equisetum arvense L. / Field Horsetail, Horsetail – Plant - 8%
Symphytum officinale L. / Comfrey - Leaf - 4%
Borago officinalis L. / Beebread, Beeplant, Borage, Talewort – Plant - 2.2%

Selenium (Se)

Physiology – Reproduction cofactor, antioxidant reactions, protein synthesis, stress tolerance

Chemistry – Plants absorb as: Selenium ions (Se^{+4} or Se^{+6}), organic selenium (Se[R]±**)

Biological

Bertholletia excels / Brazil Nut – Seed – 0.050%
Foeniculum vulgare / Fennel – Seed – 0.020%
Elytrigia repens / Wheatgrass – Plant - 0.010%
Cymbopogon citrates / Lemongrass – Plant – 0.006%
Cypripedium pubescens / Ladyslipper – Root – 0.005%

Cobalt (Co)

Physiology – Component of vitamin B12 which is essential to basic microbial processes in soil

Chemistry – Microbes utilize as: Cobaltous (Co^{+2}), cobalt chelates (Co[R]±*), or cobalamin ($C_{63}H_{88}CoN_{14}O_{14}P$)

Biological

Nyssa sylvatica / Black Gum, Black Tupelo - Leaf – 0.09%
Hydrastis canadensis L. / Goldenseal – Root -0.02%
Echinacea spp / Coneflower, Echinacea – Root – 0.01%
Dioscorea sp. / Wild Yam – Root – 0.01%
Euphrasia officinalis L. / Eyebright – Plant – 0.01%
Symphytum officinale L. / Comfrey – Root - 0.01%
Verbascum thapsus L. / Mullein – Leaf - 0.01%
Stellaria media L. / Chickweed – Plant – 0.01%
Arctium lappa L. / Burdock, Gobo, Great Burdock – Root – 0.01%
Medicago sativa subsp. sativa / Alfalfa, Lucerne – Plant – 0.01%

Chlorine (Cl)

Physiology – Osmoregulatory function, opening of stomatal guard cells, transport into the tonoplast increases tissue hydration and turgor pressure to facilitate cell elongation, and growth, photosynthesis, amylase, ATPase, protein synthesis,

Chemistry – Plants absorb as: Chloride (Cl^-)

Biological

Taraxacum officinale / Dandelion – Leaf - 2.2%
Stellaria media L. / Chickweed – Plant - 1.3%
Artemisia vulgaris L. / Mugwort – Plant - 1.1%
Portulaca oleracea L. / Purslane, Verdolaga – Plant - 0.7%
Spinacia oleracea L. / Spinach – Plant – 0.7%
Fallopia japonica / Japanese Knotweed - Plant - 0.6%
Avena sativa L. / Oats – Plant – 0.6%
Triticum aestivum L. / Wheat – Plant – 0.3%
Urtica dioica L. / European Nettle, Stinging Nettle – Leaf - 0.3%

Nickel (Ni)

Physiology – Enzyme component, nitrogen metabolism, urease component, plant immunology, and microbial nitrogen fixation

Chemistry – Plants absorb as: Nickel ions Ni^{+2}

Biological

Nyssa sylvatica / Black Gum, Black Tupelo – Leaf - 0.09%
Carya glabra / Pignut Hickory – Shoot - 0.06%
Glycine max L. / Soybean – Seed – 0.003%
Lactuca sativa L. / Lettuce; Leaf – 0.003%
Liquidambar styraciflua L. / Am. Styrax, Sweetgum – Leaf – 0.002%
Juniperus virginiana L. / Red Cedar – Shoot - 0.002%
Diospyros virginiana L. / American Persimmon – Leaf - 0.001%
Phaseolus vulgaris subsp. var. vulgaris / Beans – Fruit – 0.002%

Sodium (Na)

Physiology – C4 photosynthesis efficiency, cell enlargement osmoticium, transport cation, photosynthesis, enzyme activation

Chemistry – Plants absorb as: Soda (Na^+)

Biological

Brassica chinensis / Bok choi - Leaf - 2.2%
Brassica rapa / Turnip - Leaf - 2.1%
Lactuca sativa / Lettuce - Leaf - 1.9%
Lycium chinense / Wolfberry - Leaf - 1.8%
Beta vulgaris / Beet - Leaf - 1.7%
Chrysanthemum coronarium – Leaf - 1.6%
Ipomoea aquatic / Water spinach - Leaf - 1.5%
Borago officinalis / Borage - Plant - 1.1%

Beneficial/functional/potentially essential elements:
Iodine, lithium, strontium, tin, radium, beryllium, vanadium, mercury, silver and bromine, aluminum, and gallium

**[R]± = potential carbon based polydentate ligands ranging from proteins and polysaccharides to polynucleic and organic acids, which lend varying polarity depending on each chemical species

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