Research has shown that certain minerals are required by plants for normal growth and development. The soil is the source of these minerals, which are absorbed by the plant with the water from the soil. Even nitrogen, which is a gas in its elemental state, is normally absorbed from the soil as nitrate ions. Some soils are notoriously deficient in micro nutrients and are therefore unable to support most plant life. So-called serpentine soils, for example, are deficient in calcium, and only plants able to tolerate low levels of this mineral can survive. In modern agriculture, mineral depletion of soils is a major concern, since harvesting crops interrupts the recycling of nutrients back to the soil.

研究表明，植物正常生长和发育需要一定量的矿物质，而土壤是这些矿物质的来源，植物从土壤中吸收水分和矿物质。甚至氮气，一种主要状态的气体，通常也是从土壤中以亚硝酸离子的形式吸收。有些土地是众所周知的缺乏微量元素，不能支持大部分的植物生命。例如，所谓蛇形土地非常缺乏钙元素，只有那些能够忍受这种低含量的矿物质的植物才能在这片土地上生存。在现代农业中，土壤中矿物元素的消耗是一个主要的关注点，因为可收获的作物中止了营养物质回归土地的循环。

mineral：矿物质

nitrogen：氮气

elemental：基本的，主要的

nitrate：亚硝酸盐

ion：离子

notoriously：臭名昭彰的，众所周知的

deficient：不足的，缺乏的

nutrient：营养物，养料

serpentine：蜿蜒的，弯弯曲曲的

calcium：钙

depletion：减少消耗  
Mineral deficiencies can often be detected by specific symptoms such as chlorosis (loss of chlorophyll resulting in yellow or white leaf tissue), necrosis (isolated dead patches), anthocyanin formation (development of deep red pigmentation of leaves or stem), stunted growth, and development of woody tissue in an herbaceous plant. Soils are most commonly deficient in nitrogen and phosphorus. Nitrogen-deficient plants exhibit many of the symptoms just described. Leaves develop chlorosis; stems are short and slender, and anthocyanin discoloration occurs on stems, petioles, and lower leaf surfaces. Phosphorus-deficient plants are often stunted, with leaves turning a characteristic dark green, often with the accumulation of anthocyanin. Typically, older leaves are affected first as the phosphorus is mobilized to young growing tissue. Iron deficiency is characterized by chlorosis between veins in young leaves.

矿物质的缺乏经常可以有特殊的症状被检测出来，比如缺绿病（缺少叶绿素导致树叶组织发黄或者变白），坏死（单独坏死的一小块），花青素聚集（叶子或者根茎的红色色素过深），生长不良的，草本植物生长木质化的。土壤普遍都是缺乏氮和磷。氮元素缺乏的植物会展示出很多刚才描述的症状。落叶出现缺绿病，茎短矮细小，且茎部，叶柄，叶子底部表面的花青素褪色。缺磷的植物经常矮小，落叶变得暗绿，花青素积累过多。通常，老叶首先会被磷元素影响，然后动员到年轻的生长组织部分。缺盐的特点是在青叶的叶脉中缺绿素

chlorosis：缺绿病

chlorophyll：叶绿素

tissue：（动植物的）组织，薄片

necrosis：（人体组织的）坏死

isolated：隔离的，孤独的，使隔离，使孤独，脱离

patch：一小块，斑点

anthocyanin：花青素

formation：形成，构成

pigmentation：染色，着色

stunted：矮小的，生长受阻碍的

woody：木制的

herbaceous：草本的，叶状的

phosphorus：磷

slender：苗条的，细薄的

discoloration：褪色

petiole：叶柄，柄部

mobilize：动员，组织  
Much of the research on nutrient deficiencies is based on growing plants hydroponically, that is, in soilless liquid nutrient solutions. This technique allows researchers to create solutions that selectively omit certain nutrients and then observe the resulting effects on the plants. Hydroponics has applications beyond basic research, since it facilitates the growing of greenhouse vegetables during winter. Aeroponics, a technique in which plants are suspended and the roots misted with a nutrient solution, is another method for growing plants without soil.

很多关于营养物缺乏的研究都是基于水培中生长的植物，水培就是在无土的液体营养液中。这项技术允许研究人员去研发一种溶液，这种溶液可以选择性的释放某种营养物，然后观察在植物身上发生的影响。水培已经在基础研究上开始应用，因为它促进了植物在冬天时的温室植物的生长。气栽法是一项可以让植物悬挂，根系用营养液喷雾技术，它是另外一种让植物无需土壤生长的方法。

hydroponically：水培

facilitate：促进

aeroponics：气栽法

suspend：暂停悬挂

moist：潮湿的

mist：模糊，朝植物喷雾  
While mineral deficiencies can limit the growth of plants, an overabundance of certain minerals can be toxic and can also limit growth. Saline soils, which have high concentrations of sodium chloride and other salts, limit plant growth, and research continues to focus on developing salt-tolerant varieties of agricultural crops. Research has focused on the toxic effects of heavy metals such as lead, cadmium, mercury, and aluminum; however, even copper and zinc, which are essential elements, can become toxic in high concentrations. Although most plants cannot survive in these soils, certain plants have the ability to tolerate high levels of these minerals.

当矿物元素的缺乏会限制植物的生长，某种元素过量也是有害，且会限制植物生长。盐碱地有很高含量的氯化钠和其他盐类限制了植物的生长。而且研究继续的关注耐盐类农作物品种的培育。研究已经发现大量的金属比如铅，镉，汞，铝；然而，铜和锌是非常重要的元素，在高含量里也会变得有害。尽管大部分的植物都不能在这种土壤中生存，某些植物还是有能力忍受这些矿物质的高含量的。

toxic：有毒的

saline：含盐的

sodium：钠

chloride：氯化物

salt：盐

lead：铅

cadmium：镉

mercury：汞

aluminum：铝

copper：铜

zinc：锌  
Scientists have known for some time that certain plants, called hyperaccumulators, can concentrate minerals at levels a hundredfold or greater than normal. A survey of known hyperaccumulators identified that 75 percent of them amassed nickel; cobalt, copper, zinc, manganese, lead, and cadmium are other minerals of choice. Hyperaccumulators run the entire range of the plant world. They may be herbs, shrubs, or trees. Many members of the mustard family, spurge family, legume family, and grass family are top hyperaccumulators. Many are found in tropical and subtropical areas of the world, where accumulation of high concentrations of metals may afford some protection against plant-eating insects and microbial pathogens.

科学家们也知道有时有一些植物可以积累矿物质超过普通水平的百倍甚至更多。一个关于超累积量的研究表明超过75%的植物都积累了镍；钴，铜，锌，锰，铅，镉使其他矿物的选项。超累积量分子在整个植物世界中积累。他们可能在草本植物，灌木，或者树里。芥菜族系，豆科植物，草族系的植物成员都是超积量分子的高分布区域。很多都是热带和亚热带区域的植物，在这些区域金属的高含量积累都可能提供一些保护，对抗食草昆虫和微生物病菌

hyperaccumulator：超累积量的分子

concentrate：使集中

amassed：积累

nickel：镍

cobalt：钴

manganese：锰

herb：草本植物

shrub：灌木

mustard：芥菜

legume：豆科植物

tropical：热带的

subtropical：亚热带

microbial：微生物的

pathogen：病菌  
Only recently have investigators considered using these plants to clean up soil and waste sites that have been contaminated by toxic levels of heavy metals–an environmentally friendly approach known as phytoremediation. This scenario begins with the planting of hyperaccumulating species in the target area, such as an abandoned mine or an irrigation pond contaminated by runoff. Toxic minerals would first be absorbed by roots but later relocated to the stem and leaves. A harvest of the shoots would remove the toxic compounds off site to be burned or composted to recover the metal for industrial uses. After several years of cultivation and harvest, the site would be restored at a cost much lower than the price of excavation and reburial, the standard practice for remediation of contaminated soils. For examples, in field trials, the plant alpine pennycress removed zinc and cadmium from soils near a zinc smelter, and Indian mustard, native to Pakistan and India, has been effective in reducing levels of selenium salts by 50 percent in contaminated soils.

只有最近有投资者在考虑用这种植物来清理土壤和被重金属污染的废弃地点，这是一种对环境比较友好的环境修复方式。这种设想是想让超积累的植物生长在目标区域，比如被废弃的矿井或者被径流污染的灌溉池塘，有害的物质首先会被根部吸收，然后转移至茎和叶部。芽苗的收获会将混合物从土壤中移出后，烧毁或者合成恢复成工业使用的金属。几年的培育和收获以后，这些地方以一个比标准的被污染的土壤修复采用的挖掘和重新埋葬修复方式更小的代价恢复，。比如在一个区域测试，高山植物可以移出一个锌熔炼附近的土壤中的锌和镉。新都巴基斯坦的本地芥菜有效地降低被污染地土壤中50%含量的硒盐。

contaminate：污染，弄脏

phytoremediation：植物修复

scenario：设想，可能会发生的事

runoff：径流

relocate：转移

harvest：收获

shoot：芽，苗

compound：混合物

burn：燃烧

excavation：挖掘

reburial：重新埋葬

remediation：修复补正

trial：测试

alpine：高山植物

selenium:硒