The Universal Law of

need

Lesson Summary

In this lesson you will :

• Understand the role of trace elements as catalysts in a variety of chemical reactions that occur in the soil itself and within plants.

• Identify nine important trace elements and learn their role in nature.

• Have a detailed outline of how to maintain soil fertility in a garden.

• Become aware of current strategies for pest and disease management and contrast the effectiveness of these strategies with the ones outlined in Healthy Growing.

• Discover the role that worms, birds and bees have in your garden.

Review of Lesson 3

In Lesson 3 we looked at the damage that has been done through the use of chemical farming. We highlighted the role of the four "free" elements, oxygen, hydrogen, nitrogen and carbon as well as six major elements: calcium, phosphorus, potassium, magnesium, sulphur and silicon. The importance of developing a balanced soil was discussed. This lesson contained a lot of detailed information. To help you recall some of the details contained in Lesson 3, work through the following exercises. Refer to your notes to help you refresh your memory.

Task 1.
Refer to your notes to help you answer the following questions.
1. Which, from the four statements below is the most significant in your opinion? What are the reasons you have selected this statement.

a) If soils are maintained at a pH level of between 6.3 and 6.8 the crops grown on them will be healthy.
b) Your soil is only as fertile as the level of the most deficient major element.
c) Pests and diseases are an indication of soil that is out of balance.
d) Plants feed by releasing food for soil fungi and bacteria, which make the "food" in the soil, able to be used by the plant.

I think the most significant statement is____ because
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Task 2

Complete the following statements by inserting the name one of the major elements**.** This is not a test. It is an exercise to help you learn. Refer to the information provided in your notes.

1) _____improves a plant's resistance to water deficiency.
2) _____is the core element in chlorophyll.
3) _____immobile once incorporated into cells
4) _____is needed for cell division.
5) _____directs what comes into and leaves cells.
6) _____is found in every plant and animal cell.
7) _____regulates osmotic pressure in cells.
8) _____regulates the uptake of calcium.
9) _____is at the core of plant's energy molecule.
10) _____is involved in formation of 1250 minerals.
11)_____convert sun's energy into chemical energy.
12)_____regulates plant enzyme production
13)_____provides fuel for growth
14) _____ acts as a catalyst.
15) _____ regulates permeability of cell walls.
16) _____ is used up during seed formation.
17) _____is vital for synthesis of amino acids and oils.
18) _____ is used in conversion of nitrogen to protein.
19) _____ second to nitrogen in amount required.
20) _____deficiency causes blue-green leaves.
21) _____improves cell strength.
22) _____is involved in production of plant pectin.
23) _____bonds easily with other elements
24) _____helps build thicker plant cell walls.
25) _____stimulates creation of disease resistant compounds

The Universal Law of Need

I don't think I would be far wrong in suggesting that what you want from your garden is an abundance of unblemished, disease and insect free produce which you have grown in your weed free, easy to maintain garden. Unfortunately we don't often get what we want. This is because the Universal Law of Need always applies.

What you'll actually get is exactly what you need, which may actually be absolutely the opposite of what you want.

The words "need" and "want" are often used to mean the same thing, but they actually have a very different meaning in terms of the application of the Law of Need. What we "need" is whatever challenges us to grow in a spiritual sense. We grow when we face challenges and solve problems. We grow spiritually when we understand the reason why things happen as they do.

What we **think** we "want" is probably exactly the opposite of what we "need": a trouble free existence where everything is exactly as we would like it to be without us making any effort. If we don't think about it too deeply, we mistakenly believe we feel good when life is easy. What we don't realise is that if we always have what we want we stagnate because we don't have to face any challenges. Overcoming challenges is what **really** makes us feel good.

The problem with the Universal Law of Need is that it will not matter how much you resist, control, avoid or run away, you cannot avoid experiencing what you need. This is because the process has been designed to bring us into alignment with Universe and is failsafe. The bad news is that the thing we resist doing most, is exactly what we need to do, and will bring us the greatest benefits and the greatest happiness and sense of fulfilment.

The rule about "need" is that you will get what you need, and probably don't want, until you get to the point where you realise that what you want and what you need are one and the same thing.

Obviously in terms of your garden, what you both want and need is nutrition and health giving food. You will have this as soon as you understand what your plants and trees need in order to provide you with quality food, and you are able to provide it for them.

Your plants need:
• Soil that is completely balanced in terms of its mineral content,
• Soil that has a full range of minerals including trace elements,
• Soil that provides a home for a wide range of beneficial bacteria, fungi, algae, nematodes, protozoa, arthropods and earthworms,
• Soil that contains a generous supply of organic matter,
• Oxygen, sunlight and water,
• Freedom from poisons that destroy soil organisms.

Providing these things may require you to do things that take time and require a degree of physical exertion. In time, you will realise that what seems at first to be the hard way, actually becomes very easy because you are working with nature.

Trace Elements

Trace elements are what your plants need to be nutrient rich and healthy.

Carbon, oxygen, hydrogen, nitrogen, calcium, phosphorous, potassium, magnesium, silicon and sulphur are constituents of proteins, cells walls and mechanical structures such as leaves, stems and branches. They are the building materials for the plants. Within the plant a whole range of activities are going on at any one time. These involve a large number, probably about fifty, trace elements.

Trace element presence in soil is measured in terms of parts per million which is a very small percentage of the total volume of the soil. Amount is not an indication of importance. Without the presence of these trace elements, major minerals, micro-

organisms and organic matter do not function as nature intends. No one element works in isolation. Everything affects and is affected by all the other ingredients.

Sourcing trace elements requires some thought because, without some highly technical analysis, there is no practical way you can measure what is already within your soil, nor what you are adding to it. Blood and bone is excellent because animal bones will contain the full range of minerals that existed on the land where the animals grazed. However, if the land where they grazed was deficient in some minerals, the blood and bone will also be deficient. Fish or seaweed-based fertilizer will have a full range of minerals because minerals from the land have ended up in the oceans. Coal and its products are full of minerals because the trees and swamps that became coalfields existed millions of years ago at a time when Earth had an abundance of very lush vegetation. Crushed basalt of volcanic origin also is full of minerals. This is an excellent source of trace elements but the crusher dust takes quite a long time to break down into a form that allows the minerals to be taken up by plants. Crusher dust is probably the cheapest way to ensure that your soil has most, if not all of the trace elements it should have.

Compost is another source of trace elements. Again, the compost will only be as rich in elements as the soil on which the plants that you have turned into compost were grown.

The primary role of trace elements is as a catalyst. Trace elements control chemical processes of micro-organisms, plants, animals and humans. Without trace elements, biological reactions do not take place. This leads to abnormal development leading to death.

A catalyst is a substance that promotes chemical reactions without itself being incorporated into the end product. The most important catalysts are enzymes. Catalysts speed up reactions and reduce the amount of energy required for the reaction to take place. Catalysts allow plants to generate sufficient energy for transpiration, waste removal, nutrient intake, growth, immunity, reproduction and photosynthesis to take place. Processes such as these are regulated by 2000+ enzymes, which are present in *EVERY* cell.

Even trace elements that are regarded as poisons have a role to play in cell function and need to be present in very small amounts. Whilst we are not yet able to identify the purpose that some trace elements fulfil in plants, we can be assured that they do have a purpose and our job is to ensure that they are present.

It is thought that the range of essential elements is larger in soil micro-organisms (bacteria, fungi, algae, protozoa and invertebrates) than in the plants themselves. This is perhaps because lower organisms and invertebrates have more varied bio-chemical systems than plants and animals.

An alternative suggestion could be that we haven't yet identified the role that many of the trace elements play in plant cell function. Their absence may be due, not to the fact that they are not useful to plants, but rather that they are not present in soils where the plants grow. Inclusion of these trace elements in the soil could possibly benefit the plants in some way.

An outline of the functioning of the enzyme, carbonic anhydrase, which is critical for plants, allows us to see how enzymes in general, function. This enzyme converts CO_2 into carbonic acid as a raw material for sugar production via photosynthesis. Carbon dioxide is present in air. Even though leaves absorb this gas, conversion to carbonic acid is necessary if the CO_2 gas is to be used in photosynthesis. Zinc deficiency results in decreased carbonic anhydrase.

In gardens, application of trace elements must take into account the following:

1) Adequate levels of the major nutrients are available.

2) The pH level is between 5 and 7 if trace elements are to be available to plants.

Trace element deficiencies cause plants to be susceptible to various fungal and bacterial diseases. Disease in plants may be just a demonstration of a trace element deficiency induced weakness rather than a random occurrence.

When trace elements are not present, plants substitute others but this is an energy-consuming process. Some of the trace elements that are important for plants include Zinc, copper, manganese, boron, iron, molybdenum, selenium, iodine and cobalt. Of course it is probable that **all** elements, in minute proportions play a role in maintaining good health in both plants and animals.

Specific Trace Elements and Their Functions

Zinc is important for phosphorous uptake needed to produce energy molecules. Zinc regulates plant sugar use and the transformation of carbohydrates. It governs the production of auxins, which determine leaf size. Zinc is critical for the uptake of moisture and also critical for soil organisms, in particular the nitrogen-fixing microbes. It is also involved in protein synthesis.

Excessive levels of iron, copper, manganese and calcium inhibit zinc absorption. Excess nitrogen ties it up and high phosphorous, calcium or potassium levels also contribute to zinc deficiency, as will high pH levels.

Aluminium can be a problem in soils that have a pH of less than 5.6 because aluminium reduces the availability of phosphorous and sulphur by forming compounds. The primary damage caused by excess aluminium is damage to plant roots.

Copper increases the uptake of the ammonium form of nitrogen, which is the best form of nitrogen for making protein. It is essential for production of chlorophyll, sugar synthesis and root metabolism. It increases stalk strength and elasticity. Experiments have shown that trace elements such as copper increase vitamin levels in plants. This helps plants protect themselves from insect and fungal attack.

Excess phosphorus can tie up copper and excess nitrogen stops the uptake of copper.

Manganese is required for assimilation of nitrogen and carbon dioxide. It works with copper and potassium to build strong stalks and is required for the uptake of iron. It is absolutely essential for the germination of seeds. The explanation for this is that manganese gives the seed an electrical charge, which in turn attracts other nutrients to the seed. When manganese is deficient, nitrogen assimilation is affected and when manganese is present in abundance, disease pressure on plants is reduced.

Manganese aids in the synthesis of chlorophyll and has a part to play in the process of photosynthesis.

Boron is a critical regulator of cell division, especially the tips of roots, buds and leaves. It is required for translocation of sugar. It releases cations from the soil, especially calcium, magnesium and potassium. Boron governs salt absorption, water use and nitrogen uptake. It increases flowering. High applications of boron can be toxic in soils in which calcium levels are deficient.

Iron fixes magnesium to the chloroplast that affects the level of chlorophyll in plants. Sulphur is needed to mobilise iron in plants. It is a constituent of many enzymes and proteins including DNA.

Molybdenum's availability increases with increase in pH. It is important because it is required for the formation of the nitrogenase enzyme that plays a vital role in nitrogen fixation. Plants do not normally absorb nitrogen gas from the atmosphere. The process of nitrogen fixation converts atmospheric nitrogen to nitrate nitrogen. It is further important, because of its role in the formation of the enzyme nitrate reductase in conversion of nitrate to ammonium that is needed to make true protein in the plant. If levels of molybdenum fall below 0.4 p.p.m., its absence can limit yields.

Selenium is rare in Australian soils. It is thought by some to be the most important of all agricultural minerals because of its involvement in the production of many enzymes. Selenium affects the working of oxygen, carbon and nitrogen.

Iodine regulates potassium and helps it to move around the plant.

Cobalt stimulates beneficial bacteria in the soil. Bacteria on root nodules of legumes require cobalt to synthesis vitamin B_{12} and fix nitrogen from the air. Cobalt is a carrier of ten other minerals: titanium, vanadium, chromium, manganese, iron, nickel, copper, zinc, gallium and germanium. Cobalt combines with nitrogen and carbon to form vitamin B_{12}.

Building and Maintaining Fertility

By now you are probably beginning to understand the importance of your soil's fertility and mineral balance. Maintenance of fertility is crucial to having a healthy garden with pest and disease free plants, which are not subject to attack by insects or other predators.

In Lesson 2, we explained a way for you to get started in your garden. One of the key points in doing what we suggested was to provide a really high level of mineral and organic inputs in to

your soil. Now you need to look at how to maintain and build both the organic and mineral content of your soil.

As they grow, vegetables use the minerals in the soil. The minerals provide the food the plants need to grow, stay healthy and reproduce. Plants are constantly removing minerals from the soil and organic matter is a major source of minerals so it is also being broken down and recycled. In addition to the plants using the minerals, some are being removed by water. As water moves through the soil some of the mineral content is dissolved into the water and taken away by it.

It is possible to replace a lot of the minerals by composting and recycling the plants from your garden but what you eat or sell doesn't get put back. Whatever gets taken away must be replaced if you are going to maintain the garden's fertility.

Very few soils are super fertile initially. The exceptions are soils on flood plains which are renewed when the river floods, and soils of recent volcanic origin. Your goal should be to continually improve the soil and the only way to do this is to bring in material from outside your property.

To maintain fertility and at the same time produce great crops you need to think ahead. In our garden we work a programme that means we prepare in advance for the crops we plan to sow in 4 - 6 months' time. Using this programme it has been possible to have 2 or 3 crops per year from the same soil. We have done this for over 12 years without any depletion of soil fertility. As you will see from the lesson on soil testing, the soil has actually improved over this period.

I work with my garden shaped in mounds and trenches. The mound is where I grow my vegetables. The trenches are where I allow time for the worms, soil bacteria, fungi and insects to break down the minerals and organic matter I have placed there. Just before planting I add the contents of the trench to the soil on the mounds. I can plant immediately because the trench material has been composted and broken down for over 4 months. Weeds are not a problem because the trench area is heavily mulched. Mulch is also used on the mounds if I am not planning to plant seeds or seedlings immediately.

The location of the mounds doesn't change. The composition of the soil on the mounds changes after each crop is harvested, because the soil from the trenches is added to it.

You have already started the process with your no-dig potato area. Immediately after harvesting your potatoes you can prepare the area for your next crop. When you start to work the soil you will be surprised how soft and easy to work it has become and how deep you can push the fork without effort. There may be some cardboard remaining. Ignore it. It will soon decompose.

Initial Preparation

1) Mark out the line that will represent your first mounded ridge. The line should be across the slope. The ridge area should be about 30 - 40 cm in width to allow two rows of seeds or seedlings to be planted. Remove any weeds then fertilize the mound area with some lime or gypsum, a little animal manure, crusher dust, a good all purpose fertilizer or blood and bone.

(Use 2kg lime or gypsum, 5 kg of animal manure and crusher dust and 2 kg of all-purpose fertilizer for a row that is 5 metres long.)

2) With a fork, loosen along the line that will be your first ridge so that some of the fertilizer you have placed on top goes deeper into the mounded area. Forks are preferable to spades because spades cut worms in half. Fork prongs can be used to aerate the soil and loosen it without the need to turn it over and disturb the structure more than necessary.

3) With a fork, dig a trench alongside what will become your mounded area on the high side of the slope. Pile the soil to the downside on top of the fertilizer so that this part of your garden becomes raised up. Make the trench about 10 - 15cm deep and about 30 cm wide. The sides should not be too steep and the trench is best left a bit uneven with some of the soil left behind. The trench will become your worm farm.

4) Dig the second trench about 75 cm below the first one and parallel to it. Again, pile the dirt on the downside of the trench. Continue to work down the slope, making the ridges and trenches parallel to one another.

5) Your trench area receives the largest amount of fertilizer. For a trench 5 metres long use 20 kg of animal manure, 5 kg lime or gypsum, 5 kg of fertilizer, 10 kg of crusher dust and as much compost as you have available. If you can access seaweed, this is a great addition.

6) If you are ready to plant, cover the trench area with mulch, leaving the mounded area uncovered. If you do not plan to plant immediately, cover the whole area with mulch to prevent weed growth.

The amount of fertilizer may seem excessive. As your soil becomes more fertile, you reduce the fertilizer inputs. However, it is important that every crop that you harvest has taken minerals from the soil and these have to be replaced just to maintain the existing level of fertility.

The technique we have described means you can grow two or three crops per year on the one area if the climate allows it. Additionally, to grow nutrient dense food, you need to bring the minerals in your soil to optimum levels.

Fertility Maintenance

Except for the preparation of the mounds and trenches, fertility maintenance is the same each time your previous crop has been harvested. Weed and fertilize the mounds with a little fertilizer and compost. Dig the trenches and pile the soil from the trench on top of the mound. Add fertilizer and generous amounts of manure and compost to the trench. Cover it with mulch.

There is one word of warning about the mulch. Make sure all mulch that is covering the ground when you are re-working it is scraped off before you start work. Use the mulch in the trenches when you are finished preparing and fertilizing them. Don't dig the mulch into the soil. Apart from the expense, mulch, as it rots, takes up a lot of nitrogen, which is vital for

healthy plants. Mulch sitting on top of the soil will gradually decompose, but this does not take up nitrogen from plant roots.

Disease

Micro-organisms called pathogens are designed by nature to clean up sick and weak plants. They take advantage of any weakness in a plant and exploit it. It is actually very difficult for a pathogen to attack a healthy plant.

Most books on gardening concentrate on ways to combat disease and pests.

Books are written entirely on companion planting as a means of eradicating pests.

There is a range of programmes that come under the heading of **"Integrated Disease Management".** This approach combines a variety of techniques to enhance plant protection and to identify and treat the problems once they appear. The problem with this approach is that once the problems arise, it is already too late. The damage is done for the current crop. It is more important to prevent damage occurring in your next crop than worry about what has already happened.

Integrated Disease Management involves an integrated approach that combines a variety of techniques to enhance plant protection.

Disease is the result of work caused by fungi, bacteria, viruses and nematodes to clean up and consume weak plants. It is actually very difficult for a disease to attack a healthy plant. This is because the disease pathogen has a very thick membrane to penetrate.

Fungi pathogens include powdery and downy mildew, phytophthora, rust, pythium, fusarium wilt, mould, anthracose, and smut.

Fungi reproduce with spores, which are spread by soil, water and wind. Often fungal spores are contained in special structures that are very resilient.

Bacteria pathogens include blights, cankers, rots, scabs, gallis spots, blotches, dieback and wilts. They survive on living and non-living tissue and are rapidly spread by moisture, insects and infected seeds. Hot dry conditions stop the spread of bacteria.

Viruses rely on a host cell to reproduce. They include mosaics, bunchy top, leaf curl and sun blotch. They are spread by sap sucking insects.

Nematodes are microscopic worms, which cause root damage, deformation and stunting.

In addition to maintaining healthy soil and healthy plants, a strategy of disease prevention includes introducing predator microbes including the trichoderma, gliocladium virens, bacillus subtillus and nematophagous fungi.

Trichoderma produce enzymes that collapse and digest the host fungi and produce water-soluble antibiotics. They live in soil, water and on leaf surfaces.

Gliocladium virens wrap themselves around the host and dissolve the outer wall with powerful enzymes. This species also produces a broad-spectrum antibiotic, which kills many soil pathogens.

Bacillus subtillus produces metabolites that inhibit pathogenic fungal and bacterial growth and trigger an immune response in the plant.

Nematophagous fungi form special nematode traps.

The stated aim of **Integrated Pest Management** is to manage pests rather than to eradicate them, and to do it in a way that is least disruptive to the agricultural system being used. The integrated pest management system advocates that a grower is only justified in using control strategies (poisons) when the potential damage likely to be caused by the pest is greater than the cost of controlling the pest. This is a piece of advice, which makes economic sense.

Integrated Pest Management involves understanding pest biology and ecology, identification and monitoring the pest that is causing the damage and selecting the appropriate control strategy including:

• **biologic control** using introduced parasites, predators and pathogens and encouraging existing natural enemies.

• **natural pest disrupters** such as pheromones, baits and anti-biotics.

• **varietal resistance**, which involves choosing to grow those varieties that demonstrate the greatest resistance to pests.

• **cultural practice** such as time of planting and/or harvesting, crop rotation, fertilization and irrigation regimes and removal of alternative pest hosts.

• **chemical reduction / accuracy** using selective pesticides, and better placement and timing of poisons being used.

The aims of the integrated pest management movement are excellent but it seems that many of the "appropriate" control strategies seem to be restricted to "what poison to use, how apply it, when to use it, and how much of it to use". The choice often seems to be restricted to the question of whether to use systemic, contact, fumigants, protectant or residual poisons.

When crops are not healthy, they are attacked by a wide range of pests and diseases. If a grower is forced to use chemical control (poison) for one problem, the effectiveness of biological control options is reduced.

The whole approach ignores the fact that plants that are healthy because they grow in nutrient rich, balanced soils do not get attacked by pests.

The Good Guys: Birds and Bees

Two of the most valuable creatures you can have in your garden are birds and bees.

Birds

A little known fact is that birdsong in the early morning stimulates plants to open their stomata to take in carbon dioxide and release oxygen. Birds are great predators. They control many of the insects that could otherwise cause damage to crops.

People cannot believe that the birds that live on "Castelen" are so friendly. Kookaburras regularly perch on the kitchen window sill hopefully waiting for a slice of steak or some minced lamb. When we work in the garden butcher birds are always around waiting for a tasty grub or insect to emerge as we weed or dig. They will sit on a branch on a nearby tree making sure they are close enough to see whether there is any food being uncovered. Some of the cheeky ones perch on my head as their vantage point, or insist on sitting on the spade or the fork as I work. I am totally convinced that the birds talk to one another. One will come and investigate what I am doing and if there's lots of food around it then calls to its mates. I think the message must be "Grub's up". Within seconds they all arrive. If I try to mimic their calls, they respond and we have long conversations.

The variety and number of birds in our garden provides great evidence of a "safe" environment. One of my greatest joys in recent years has been to see the return of number of varieties of little birds. Blue wrens, which I haven't seen for years, visit frequently. Little red and black finches visit the red flowers outside my kitchen window at a different time of the year. Sometimes we have crowds of bower birds swirling and swooping around the house.

Like insects, birds only take fruit that is not nutritionally perfect or which is over-ripe. Strawberries are safe as long as I don't leave them too long. Cherry guavas are eaten when they are ready to fall from the bush. The figs are left untouched unless I forget to pick them and allow them to become over-ripe. Even the scrub turkeys rarely damage the vegetables in the garden, even though they patrol every day. When they do start to dig something up it alerts me to something being wrong with the soil in that location. The only bird that does any damage is the lyre bird and I can forgive that because I feel privileged that I have lyre birds around who visit us occasionally.

Bees

Marcus is interested in finding out more about growing vegetables and fruit and he has volunteered his services so he can learn by working here. For years I have wanted to have bees at Castelen so I was delighted when he asked if he could bring his bees to live here. They're doing well and producing a lot of honey, so Marcus is planning to set up a second beehive. Having large numbers of bees guarantees that there are plenty around when the avocado and fruit trees produce blossoms.

At a time when bee numbers are declining rapidly around the world, a problem that is causing great concern, I am fortunate to have a beehive on my property and I don't even have to take care of it.

Colony Collapse Disorder is a fancy name for hives with no bees. The phenomenon was first noticed in 2004. Since then, up to 90% of commercial beehives in some areas of the USA have collapsed. Current thinking is that the factory farm aspect of beekeeping combined with an onslaught of negative environmental factors put stress on the colonies, so that they are more susceptible to whatever it is that is killing them.

Commercially operated hives are hauled long distances by truck to provide pollination services to industrial agricultural crops. This exposes them to agricultural chemicals and genetically modified crops. Pesticides are used in commercial hives to fumigate for varoa mites, and antibiotics are fed to the bees to prevent disease. These measures are obviously not effective.

Interestingly, bees kept on organic farms are not experiencing problems. Natural bees are not being affected either.

One culprit thought to be guilty of creating the problem is the varoa mite, which enters a hive and multiplies, gradually weakening the colony so that it dies within a few years. Varoa mites enter the cells containing bee larvae before they are capped. While the cell remains capped, the bee larvae transforms into an adult. If the cell contains varoa mites, the larva is eaten and the mites breed and multiply. Interestingly, naturally occurring bees have been seen to uncap infested cells and kill the mites. This does not happen in commercial hives.

In Germany it is suspected that Bayer Crop Science is guilty of marketing chemicals, which impede the bee's sophisticated communication and navigation systems. These chemicals are now banned in Germany, France, Italy, Slovenia and England and a British supermarket has prohibited suppliers of its fresh produce using pesticides connected to bee colony collapse.

A fascinating theory about dwindling bee populations has been postulated by John Macdonald, a Pennsylvanian beekeeper. He blames genetically modified crops for the problem. He explains his thinking in the following way.

Bacillus thuringiensis (Bt) has been used for decades to control crop damage by butterfly larvae. Bt causes crystallisation in the gut of boring larvae. This same Bt now supplies the most commonly used segment for transgenic DNA. Now, instead of spraying Bt on the crops to kill targeted insects, it is being used to create genes containing insecticidal traits within the plants themselves. Since genes are replicated at every level, every cell in genetically modified plants contains this insecticide-producing gene. The gene causes plants to produce a toxic protein called Cry1Ab.

The most commonly grown plant, which contains this insecticide-producing gene is corn. Bees forage heavily on corn flowers to obtain pollen for the rearing of young bees.

Due to lack of interest in his theories John Macdonald carried out his own tests to check the validity of his hypothesis. Some hives were placed where bees had access to GM corn. Some were placed where there was no access.

Bees in the hives near GM corn did not gain weight and when the hives were opened up it was obvious that the bees had not collected enough food to feed the bee colony during winter. By comparison, bees in the non-GM areas did gain weight and had plenty of food.

Tests carried out in Mexico have confirmed John Macdonald's tests. Their studies showed that bees exposed to Cry1Ab had much slower learning rates.

John Macdonald's conclusion was that Bt does not kill bees but it reduces their health and their ability to collect enough food to sustain the hive.

If we establish poison free gardens for no other reason than to protect the world's bee population from extinction, the time and effort will be well spent since bees pollinate some 80% of our crops. Without them, we would be faced with extreme danger of starvation.

Review Exercise.

1. Task 1: Sourcing Inputs

Your job following this lesson is to check out the inputs that are available locally that will provide you with a good source of organic material and trace elements. Think of the industries that are located in your area and the waste that is being generated from those industries. If you live in a suburban residential area, you have fresh food markets, which generate huge quantities of waste organic matter. It is likely that in the area there will be contract gardeners and lawn mowing contractors. You could contact them and suggest they leave their lawn clippings at your place rather than taking them to the local tip. There might be piles of fallen leaves in autumn that make great mulch. If you live in a more rural area you could identify sources of industrial waste such as cottonseed, grape marc, peanut husks, animal manures and sawdust. Blood and bone meal is a by-product from slaughterhouses. If you live near the sea you could collect seaweed. Crusher dust will come from quarries. Here on Mt Tamborine the local Council provides a green waste service. Periodically they woodchip all the green waste and make it available, free, to local residents. It is time consuming loading the mulch, but it is a great service and is one of the factors that contributes to the very beautiful gardens in the area.

Summarise your findings below:

Product 1

Description: _____

Location of source: _____

Contact name: _____ Telephone: _____

Address: _____

Cost: _____ Transport _____

Product 2

Description: _____

Location of source: _____

Contact name: _____ Telephone: _____

Address: _____

Cost: _____ Transport _____

Task 2

Using a scale of 1 - 5 where 5 equals closely aligned to how you think and believe and 1 equates with totally irrelevant, rank the following ideas in terms of how important they are for you, a gardener, to take into account.

a) Minerals, plants and living creatures do not exist in isolation. They are all interrelated. If you remove one element, you cause a change in the entire complex of interrelationships. 1, 2, 3, 4, 5

b) Vegetables contain only those elements present in the soil where the plants grow. 1, 2, 3, 4, 5

c) Trace elements control chemical processes including photosynthesis, reproduction and growth within plants. 1, 2, 3, 4, 5

d) Trace elements are only effective if adequate levels of major minerals are available. 1, 2, 3, 4, 5

e) Trace element deficiencies make plants susceptible to disease. 1, 2, 3, 4, 5

f) Healthy plants are not attacked by pests or diseases. 1, 2, 3, 4, 5

Task 3

Link the correct trace element with the statement provided.
Refer to your notes to help you complete this review exercise.

1. Essential for chlorophyll production _____
2. Regulates cell division _____
3. Fixes magnesium in the chloroplast _____
4. Regulates the transformation of carbohydrates _____
5. Helps assimilation of nitrogen _____
6. Crucial for calcium uptake _____
7. Helps assimilation of carbon dioxide _____
8. Releases cations from the soil _____
9. Enhances phosphorus uptake _____
10. Component of 200 different enzymes _____
11. Vital in nitrogen fixing _____
12. Needed to mobilise iron in plants _____

Task 4

Select one piece of information from this lesson that you believe is significant in terms of how you think about your garden. Explain why you believe it is significant.

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