# BOWLS SOUTH AFRICA

# LEVEL 2
# GREENKEEPING

## EDITION ONE

**Compiled by**
**Bryan Hart**

This book has been compiled to assist lawn bowls greenkeepers after they have successfully completed the BSA Level One course and three years practical experience. In this book you will gain a sound understanding of nutrients, soil, soil analysis, pests, and diseases.

The book is better understood after receiving the Level Two lecture. Where material and pictures could not be found they have been taken from the Internet for clarification during lectures.

I would like to thank the Members who served on the Bowls South Africa Greens Committee with me when planning the Level One and Two for their input and patience when waiting for this book to be compiled. Your contribution will be invaluable to many future greenkeepers.

It has taken me many hours to compile this book which I hope will assist greenkeepers to better understand the greenkeeping world and produce the kind of quality playing surfaces that all bowlers appreciate.

Bryan Hart

Bowls South Africa Greens Convener

# INDEX

# NUTRIENTS

**WHY DO WE FERTILISE?**

Plants require the full range of nutrients for optimal growth and development and to complete their lifecycle.
There are 5 categories of nutrients: amino acids, carbohydrates, fatty acids, vitamins, and mineral nutrients.
What the plant cannot produce and what the soil cannot make available, the greenkeeper supplies by means of applying fertilisers.

**HOW DO PLANTS ABSORB THESE NUTRIENTS?**

a. **Via Stomata**

Stomata are microscopic pores located on all the plant parts above the soil. Greater concentration of these structures is found on the lower and upper surfaces of the leaf. Stomata consist of guard cells shaped as half-moons that can open and close depending on environmental conditions.
During hot summer conditions stomata open during the early morning to absorb water, close when the temperature increases during the day and opens late afternoon to absorb water.

**b. Via Roots**

Most plant root systems are located underground. Their main function is to anchor the plant, absorb water and nutrients and store nutrients. Nutrients are absorbed through the root cap and translocated to the rest of the plant.

**WHAT ARE MINERAL NUTRIENTS AND THEIR FUNCTIONS?**

Oxygen, carbon, and hydrogen are 3 nutrients that the plant obtains from air, sunlight and water. In addition to these nutrients there are chemical elements in the soil that are also needed for optimal plant growth.
These elements are divided into two groups namely: macronutrients and micronutrients.

- Macronutrients: Needed in large quantities
- Micronutrients: Needed in smaller quantities, but essential for optimal growth and development.

**Nutrient Deficiency:**

This occurs when a nutrient is not in the correct quantities as required by the plant therefore the plant cannot complete the growth stage.

**Nutrient Toxicity:**

This phenomenon occurs when the nutrient quantities exceed the needs of the plant. The result is a decrease in plant growth.

The following are terms used for nutrient deficiencies:
**Chlorosis**: = Yellowing of leaf tissue veins turn yellow.

**Interveinal Chlorosis**: = Leaf veins remain green but the tissue between turns yellow due to a lack of chlorophyll.
**Necrosis:** = Plant tissue turns brown and eventually dies.
This can happen gradually on a living plant.

**Stunting:** = Decrease in plant growth resulting in shorter height of plant.

| **NUTRIENT** | **FUNCTION** | **DEFICIENCY** | **EXCESS** |
|---|---|---|---|
| NITROGEN | Gives leaves green colour<br>Responsible for growth of shoots and leaves | - Leaves turn yellow<br>- Stunted growth | - Dark green leaves which is less drought, disease, and insect resistant |
| PHOSPHOROUS | - Responsible for root growth | - Underdeveloped root system results in stunted plant growth, older leaves turn blue purple | - Micronutrient deficiencies occur e.g., iron and zinc |
| POTASSIUM | - Responsible for the quality and size of roots | Older leaves turn yellow, then brown and die | - Negatively affects the uptake of magnesium and calcium |
| CALCIUM | - Aids in the manufacture of proteins - Component of cell walls | Reduced Growth | - Causes micronutrient deficiencies e.g., magnesium or potassium |
| MAGNESIUM | - Constituent of chlorophyll | - Veins of leaves turn yellow | - Plants can tolerate high concentrations of magnesium |
| SULPHUR | - Involved in the formation of chlorophyll | - Plants turn yellow and growth is stunted | - Excess Sulphur results in the premature dropping off leaves |
| IRON | - Needed to produce chlorophyll | - Leaf veins turn yellow | - Bronzing of leaves, presents of small brown spots on leaves |
| MANGANESE | - Needed to produce chlorophyll | - Young leaf mottling, veins of leaf turn yellow | - Brown spots present on leaves |

| | | | |
|---|---|---|---|
| ZINC | - Needed in enzyme activation | - Reduced leaf size | - Excess results in iron deficiency |
| BORON | - Needed for tissue growth | - Leads to tissue breakdown, death of growing tips and leaves are deformed | - Leaf tips become yellow, die, and fall off |
| COPPER | - Needed in enzyme activation | - Reduced leaf size | - Excess results in iron deficiency |

Most of the time adverse soil conditions results in soil nutrients being unavailable to the plant or the nutrients are immobile and cannot be translocated to the various parts of the plant body.

**General**

The uptake of nutrients by turfgrass may vary with "yield" but ratios stay much the same. Nutrients removed from a bowling green producing 1,1 to 1,4 tonnes dry matter per annum will use the elemental state approximately:

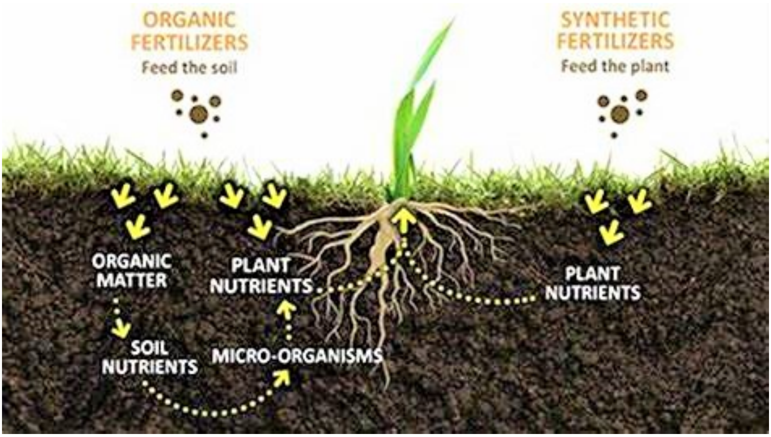
Nitrogen (N) = 50 kg
Phosphate (P) = 3 kg
Potash (K) = 35 kg

Uptake of other macro-elements Sulphur (S), Calcium (Ca), and Magnesium (Mg) are more or less in the range of P. The main micro-elements Zinc (Zn), Boron (B), Molybdenum (Mo), Iron (Fe), Manganese (Mn) and Copper (Cu) are used only in very small quantities.

| | **N** | **P** | **K** |
|---|---|---|---|
| A Green per season requires the following: | 53% | 3% | 37% |

To determine the quantity of N, P and K in a bag i.e. 5 ; 1 ; 5 (36)
Add the figures on the bag, 5 + 1 + 5 = 11
36 divided by 11 = 3,3%
N = 5 x 3,3 = 16,5%
P = 1 x 3,3 = 3,3 %
K = 5 x 3,3 = 16,5 %

# ORGANIC FERTILISER VERSUS SYNTHETIC




A **chemical fertilizer** is defined as any inorganic material of wholly or partially synthetic origin that is added to soil to sustain plant growth.
**Chemical fertilizers** are rich equally in three essential nutrients that are needed for crops and always ready for immediate supply of nutrients to plants if situation demands.

**Organic fertilizers** are substances that are derived from the remains or by-products of natural organisms which contain the essential nutrients for plant growth.
Organic fertilisers add natural nutrients to the soil, increases soil organic matter, improves soil structure and tilth, improves water holding capacity, reduces soil crusting problems, reduces erosion from wind and water, and provide a slow and consistent release of nutrients.

## GREENS SOIL ANALYSIS

This is to be used as a guideline only.
This is a typical soil analysis report from Cedara – KZN.

**SUMMARY OF ANALYTICAL RESULTS**
(These results may not be used in litigation)

Batch : 523 Year : 2010 Printed : 2010/08/16

| Lab number | Sample density g/mL | P mg/L | K mg/L | Ca mg/L | Mg mg/L | Exch. acidity cmol/L | Total cations cmol/L | Acid sat. % | pH (KCl) | Zn mg/L | Mn mg/L | Cu mg/L | MIR clay % | MIR org. C % | MIR N % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F12077 | 1.27 | 150 | 441 | 1406 | 257 | 0.15 | 10.41 | 1 | 6.00 | 17.6 | 14 | 7.7 | 5 | 3.2 | 0.24 |

| YOUR SAMPLE ID | LAB NUMBER | MID INFRARED ESTIMATES | | |
|---|---|---|---|---|
| | | **ORG .C** % | **N** % | **CLAY** % |
| A - GREEN | F10665 | 2.4 | 0.21 | 18 |

**Note** - **mg/L is the same as ppm.**

**C.E.C. (Cation Exchange Capacity) – Desired range = 5 to 25 c mol/kg**

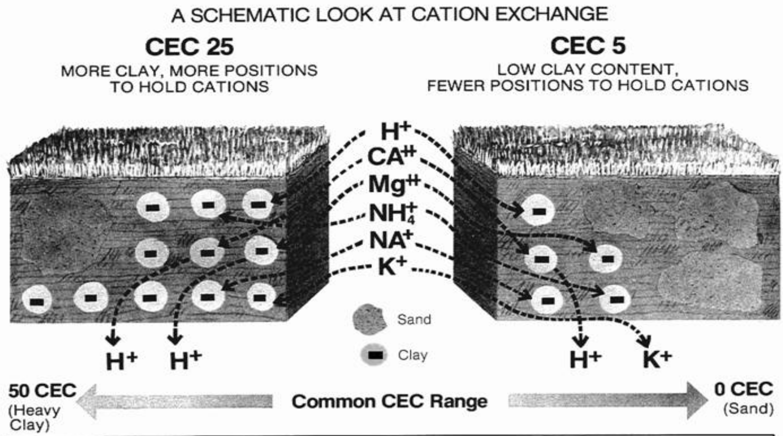
CEC measures the soil's ability to hold elements with positive charges (cations) such as calcium, magnesium, potassium, sodium, and hydrogen.
The CEC of a soil will increase with the increasing amount of clay and organic matter.
The cation exchange capacity of a soil is determined by the amount of clay and/or humus that is present.
Sandy soils with very little organic matter (OM) have a low C.E.C., but heavy clay soils with high levels of Organic Matter (OM) have a much higher C.E.C.
That means they have a much better ability to hold cations.
The C.E.C. is expressed in milli-equivalents per 100 grams (meq/100g) of soil. The larger this number, the more cations the soil can hold.

Soil analysis results denoting low CEC soils, such as sandy soil, will need the fertilization adjusted to deliver less fertilizer per application, but performed more times per year. Sandy soils don't have as many negative charges to hold nutrients, so it will need to be approached a little differently

The main ions associated with CEC in soils are exchangeable cations Calcium (Ca), Magnesium (Mg), Sodium (Na), and Potassium (K) these are referred to as base cations (CEC).

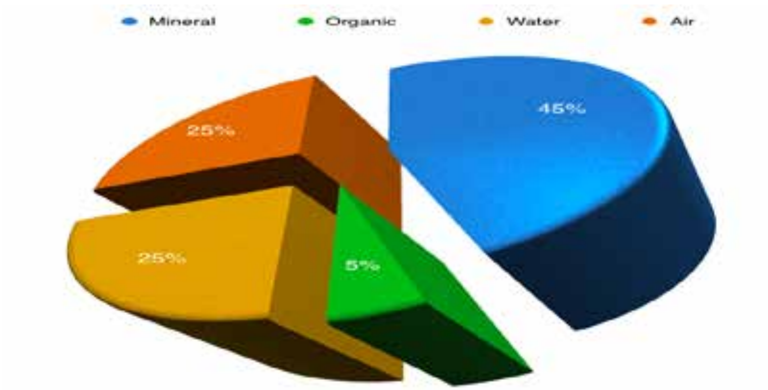
**Anion** vs. **Cation**. Ions result from atoms or molecules that have gained or lost one or more valence electrons, giving them a positive or negative charge. Those with a negative charge are called **anions** and those with a positive charge are called **cations**.

Under a microscope, root hairs grow into pyrogenic carbon particle, which enhance electron networks.




| SOME PRACTICAL APPLICATIONS | |
|---|---|
| Soils with CEC 11-50 Range | Soils with CEC 1-10 Range |
| • High clay content<br>• More lime required to correct a given pH<br>• Greater capacity to hold nutrients in a given soil depth<br>• Physical ramifications of a soil with a high clay content<br>• High water-holding capacity | • High sand content<br>• Nitrogen and potassium leaching more likely<br>• Less lime required to correct a given pH<br>• Physical ramifications of a soil with a high sand content<br>• Low water-holding capacity |

**PHYSICAL MAKE UP OF SOIL**




**RATIOS**

The ratio of Ca: K : Mg when measured in parts per million (ppm) should be about 7-10 : 2 : 1 producing Base Saturation percentages of approximately 60-70% Calcium, 3-10% Magnesium, 2-5% Potassium, 0 – 2% Sodium. In most bowls greens the rootzones remainder are hydrogen (H) 10-15% and other cations (2-5%) providing a pH of 5.5 – 6.5.

**Percent Base Saturation (Calculated Cation Saturation)**

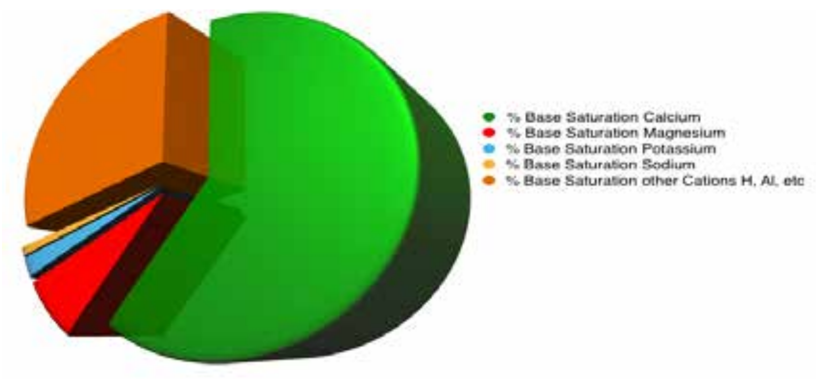
Is what % of the exchange sites are occupied by the cations in the soil- hydrogen, calcium, magnesium, potassium.

Soil test will give you normal ranges and base recommendations on that.

**Base Saturation: % Calcium, % Magnesium and % Potassium:**

Base Saturation is the extent to which the adsorption complex of a soil is saturated with exchangeable cations other than hydrogen or aluminum. It is expressed as a percentage of the total CEC.

In an ideal situation the Base Saturation would look like this:



**Calcium to Magnesium Ratio: IDEAL 7: 1 Ratio.**
This ratio is calculated based on percentage saturation of the soil CEC by each element. This ratio should be considered when lime is added to the soil. If the ratio is 1:1 or less (less Ca than Mg), a low magnesium limestone should be used.
The ratio of calcium to magnesium is important. This indicates a healthy balance in the soil. Diseases, weeds, and insect infestations appear when the ratio falls below this level!

**Magnesium to Potassium Ratio: Should be greater than 2:1. Ratio.**
In other words, the percent base saturation of Mg should be at least two times the percent base saturation of K. High K frequently results in reduced uptake of Mg by plants. Therefore, to help prevent plant nutrient imbalance, additional Mg may be required to maintain Mg to K ratio of at least 2:1.

## Interpretation of soil analysis results (IDEAL Range Guideline)

The figures given below can be used as a general guide to the interpretation of soil analysis results.
**Note** - **mg/L is the same as ppm.**
**Soil pH**:
**Ideal = 5,5 – 7,0** Lower than 5,5 = Acidic To raise – Use Dolomitic Lime
Higher than 7, 0 = Alkaline. To lower – Use Ammonia Sulphate.

**Nitrogen (N)** - **Ideal = 50 to 100kg/ha**

- Nitrogen is a major component of chlorophyll, the compound by which plants use sunlight energy for photosynthesis to produce sugars from water and carbon dioxide.
- It plays an important part in soil fertility management, so it has higher concentration compared to carbon, hydrogen, and oxygen.
- Nitrogen imparts vigorous vegetative growth, dark green colour to plants.
- Nitrogen is an energy-transfer compound, such as ATP (adenosine triphosphate). ATP allows cells to conserve and use the energy released in metabolism in plants.
- Nitrogen is a major component of amino acids.
- It is an essential constituent of protein and present in many other compounds of physiological importance in plant metabolism.
- Nitrogen produces early growth and results in delay in maturity in plants.

**Phosphorus: (P) Bray 2 Ideal = 32 to 48 ppm**
Phosphorus plays a vital role in virtually every plant process that involves energy transfer.

Phosphorus represents the second number on a bag of fertilizer. A bag of 14-3-8 contains 3% P by weight. Established grasses don't require a lot of added phosphorus unless a soil test requires it. Mature grasses are very good at removing it from the soil.

Plants cannot grow and develop properly without Phosphorus. Its use in root development has been known and well documented for many years. It also increases the plant's disease resistance and improving heat and drought tolerance.

What is important to know about Phosphorus is that it is relatively immobile in the soil and almost never leaches.

**Potassium: (K) Ideal = 191 to 201 ppm**

Basically, potassium (K) is responsible for many other vital processes such as water and nutrient transportation, protein, and starch synthesis. Potassium represents the third number on a bag of fertilizer. A bag of 14-3-8 would contain 8% K by weight. The understanding and the use of K have changed in recent years, as scientists better understand how the plants use it. One of your greens biggest enemies is stress. Potassium decreases stress and helps it to endure tough conditions. Additional applications of K have been a lifesaver for many greens by increasing the grass' ability to withstand traffic, heat, and drought problems of summer.

**Magnesium (Mg) Ideal = 109 to 115 ppm**

Magnesium is the powerhouse behind photosynthesis in plants. Without magnesium, chlorophyll cannot capture sun energy needed for photosynthesis. In short, magnesium is required to give leaves their green colour.

**Sulphur (S) Ideal = 11 to 18 ppm**

Sulphur is responsible for the formation of chlorophyll that permits photosynthesis through which plants produce starch, sugars, oils, fats, vitamins, and other compounds.

**Organic Matter - Ideal = 3 to 5%**

Soil organic matter is the fraction of the soil that consists of plant or animal tissue in various stages of breakdown (decomposition). Most of our productive agricultural soils have between 3 and 6% organic matter. Soil organic matter contributes to soil productivity in many ways.

**Organic Carbon - Ideal = 2 to 4 %**

Soil organic carbon is a measurable component of soil organic matter. Organic carbon makes up just 2–10% of most soil's mass and has an important role in the physical, chemical, and biological function of agricultural soils.

**Calcium (Ca) Ideal = 925 to 974 ppm**

Calcium plays a very important role in overall growth of plants. It helps in absorption of major nutrients by the roots in the presence of water. It is essential for formation and integrity of plant cell wall and hence very essential

**Trace Elements**

**Boron (B)**: Ideal = **1 to 2 ppm**

The main functions of boron relate to cell wall strength and development, cell division, fruit and seed development, sugar transport, and hormone development.

**Manganese (Mn)**: **Ideal = 10 to 100ppm**
Manganese participates in the photosynthesis process and in chlorophyll production.

**Zinc (Zn): Ideal = 1 to 4 ppm**
It is important for production of plant growth hormones and proteins and is involved in sugar consumption. Good root development as well as carbohydrate and chlorophyll formation is also dependent on zinc.

**Copper (Cu): (Ideal) = 1 to 2 ppm**
Essential for the respiration process

**Iron (Fe) Ideal = 50 to 200 ppm**
It is important for the development and function of chlorophyll and a range of enzymes and proteins.

**Sodium (Na) (Ideal) = 24 to 25 ppm**
When SAR (Soduim Absorption Ratio) is greater than 13, the **soil** is called a **sodic soil**.
Excess **sodium** in **sodic soils** causes soil particles to repel each other, preventing the formation of soil aggregates.
Sodium is not a plant nutrient, but it does play a role in soil health.

**Aluminum(Al) (Ideal) < 20ppm**
Aluminium is also more available to plants in acidic soils (soils with a very low pH)
Non-essential for plant growth, available or soluble aluminium can be toxic to plants

# SOIL

**Soil Chemistry**

The items of interest in the soil's chemistry are largely concerned with the relative availability of nutrients (essential elements). Key influences here are Electrical Conductivity, which tells us how *salty* the soil is. The concentration of mineral salts in the soil can build up to a level that is detrimental to plant health. A high concentration of mineral salts in the soil can cause the process of **Osmosis** in the plant to slow or in severe cases even go into reverse, effectively sucking moisture back out of the plant roots.

The relative proportions of the mineral and organic components dictate the soil's Structure and texture.

**Soil Biology**

Biology deals with living organisms and in a healthy bowling green there are a great many of them ranging from the grasses we aim to grow (along with the odd weed and moss from time to time), worms, insects and a massive range of micro-organisms grouped into types such as Bacteria, Fungi, Nematodes etc. In a teaspoonful of healthy, thriving soil there will be 1 billion of these microscopic organisms and every one of them has a role to play in the soil/turf eco-system.

Beneath our feet, there is the most remarkable factory where fertiliser for our turf is essentially produced for free, but only if the soil is working properly. In simple terms bacteria eat the proteins, sugars and carbohydrates that leak from the roots of the plants. Fungi mop up any juice exuded by the roots that they can, but most live on the more woody cellulose and lignin found in thatch. In turn, these bacteria and fungi become food themselves for predatory microbes including nematodes and protozoa. These predators excrete ammonium, which is then converted to nitrate by bacteria in the presence of oxygen. Nitrate can be used directly by the plants and so this amazing cycle of growth and decay continues, producing everything needed by the plants in terms of soil nutrients.

**Soil Physics**

The Physical condition of your green's rootzone/soil has far reaching effects. As we have seen, one of those is that it can affect the soil's ability to provide Nutrients to the plants, but it goes a lot further than that.

**Soil Structure** defines how well the soil particles aggregate to create a stable medium for healthy plant growth and surface performance, but so far, we've only accounted for 50% of the soil volume.

Incredibly the other 50% of the volume of the soil is just space! Well not just any space, but a split between Water and Air space.

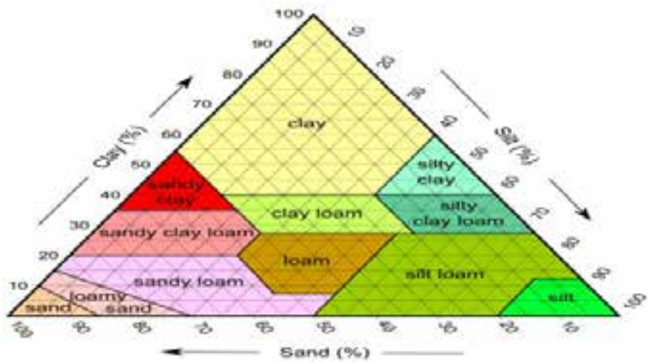
Water occupies small spaces between the soil particles called **Micro-Pores**, whilst Air occupies the large spaces called **Macro-Pores**. The relative amounts of Micro and Macro Porosity is dictated by the Soil's *texture*.

**Soil Texture** is a measure of the relative proportions of Sand, Silt and Clay that make up the mineral component of the soil. Soil Texture is defined and categorised according to the Soil Texture Triangle.

**SOIL - Particle sizes**

| TEXTURE of SOIL | SIZE | CEC | PARTICLES per Gram |
|---|---|---|---|
| Gravel | 2,0mm – 3,4mm | 3% | |
| Very coarse sand | 2,0mm – 1,0mm | 10% | 95 approx |
| Coarse sand | 1,0mm – 0,50mm | 30% | 730 |
| Medium | 0,50mm – 0,25mm | 60% (ideal) | 5 800 |
| Fine | 0,25mm – 0,15mm | 40% | 46 200 |
| Very fine | 0,15mm– 0,005mm | 20% | 722 600 |
| Silt | 0,05mm – 0,002mm | 5% | 5 696 000 |
| CLAY | < 0,002mm | 3% | 91 000 000 000 |

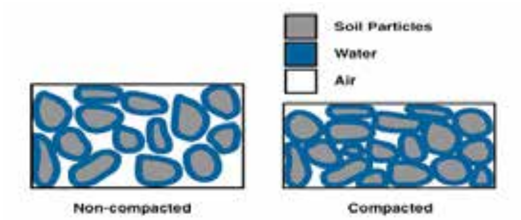
The chart below shows the ideal physical makeup of the soil. What it shows is that 45% of the soil's volume should be mineral matter (Sand, Silt and Clay) and around 5% should ideally be Organic Matter (Humus) (Compost).




Each of the different coloured segments in the triangle is called a **Soil Textural Class** and the ideal sector for the optimum performance in a bowling green is the **Sandy Loam** segment. The soil textural class of your rootzone influences a whole range of Chemical and Physical processes in your green.
Drainage is an obvious process that is dictated by soil texture. When the soil has a high sand content, it will drain quickly, but if there is too much sand then it might drain too quickly and be unable to provide enough moisture to the plants. The point at which the soil starts to become too sandy is known as **Peak Sand**.
Soils that are beyond Peak Sand are usually lacking in clay and humus, meaning that they can't hold on to sufficient moisture or nutrition to keep the turf healthy.

Soil's that don't have enough sand can become easily compacted, meaning that drainage is impeded, as are many biological functions in the soil. This process is called **Compaction** and it simply means that the soil particles are more readily squeezed together by the weight of foot and maintenance traffic. When the soil is compacted, Macro Porosity suffers with the resulting slowdown in the drainage capacity of the soil. Another negative effect is that there is less room for Air in the soil making it become anaerobic (lacking Oxygen) and this negatively impacts the Soil's Biology.

The ideal soil for producing a high-performance bowling green will have a physical make up close to that illustrated below:



# MYCORRHIZAE

One very important group of fungi that live in and around the roots of our fine grasses are called mycorrhizae, from the Latin via Greek for fungus (myco) and root (rhiza). Mycorrhizal fungi associate with the root systems of our perennial grasses and together they form a symbiotic relationship where the Mycorrhizal fungi extend their hyphae into the soil, produce enzymes that make phosphate and other nutrients available to the plant and then transfer these nutrients, trace elements and water back to the plant in a form it can readily use to supply the raw ingredients for growth. We can think of these fungi as something akin to a root extension as they extend the effective root area of the plant many times over, allowing it to access resources from a far greater volume of soil than it otherwise would be able to.
This relationship makes grasses twice as efficient as annuals, which rely on fertiliser inputs to grow. Of course, this seemingly miraculous symbiotic activity goes on in natural grassland systems and closer to home, in areas such as meadows and even golf course fairways without fertiliser inputs and without thatch building up!
**NB. COMPACTION PREVENTS THIS FROM SUCCEEDING.**

**MYCORRHIZAL FUNGI**

**PESTICIDES & MYCORRHIZAL FUNGI**

**Fungicides**
Care must be taken when applying fungicides to mycorrhizal plants though there is plenty of scope to combine mycorrhizal fungi with fungicides; in what is known as an enhanced integrated pest management programme (IPM).
The following guidelines will help you get the best results with mycorrhizae. It must be remembered that at recommended label rates it is highly unlikely that any fungicide will completely eliminate mycorrhizal colonisation.

**Non-Systemic Fungicides**
Foliar Application – Has no detrimental effect and can be used at any time.

Soil Drench – Do not apply within 3-4 weeks of planting or applying mycorrhizal inoculant. Once the fungi have colonised the root system non systemic fungicides have little effect as they do not penetrate the root system.

**Systemic Fungicides**

Foliar Application – fungicide builds up in the plant and is detrimental to mycorrhizal colonization. Do not apply for 2-3 weeks before inoculation and 3-4 weeks after inoculation.
Soil Drench – fungicide builds up in the plant and is detrimental to mycorrhizal colonization. Do not apply for 3 weeks before inoculation and 3-4 weeks after inoculation.

**Insecticides**

There are no reports of insecticides harming mycorrhizal fungi when applied at recommended label rates**.**

**Herbicides**

If herbicides are used to kill off a wide area of plants, then the mycorrhizae will only survive a short time in the soil without a host plant and inoculation of the new plants will be needed.

**REINTRODUCTION OF EFFICIENT MICROBES**

The organisms making up EM are very hungry and unless you supply a readymade food in the root zone they will starve. Your grass plant normally supplies the CHO to feed the existing organisms in the soil via the roots, but it does not have the capacity to feed all the organisms in the EM until the additional leaves and chlorophyll produced by the action of the EM can produce more CHO.

If you have a "heat sensitive" substance (like EM) in the first water you apply, the dry hot particles might hurt the EM If there is already a coating of water on the particles, they will be cooler and more able to allow the water containing EM to pass through the soil layers.
If you apply water to a dry green the first water will attach itself to the surface of the particles in the soil, this water will remain as "retained water" and even the root hairs are not able to use or absorb that water. If you go on applying water to the green, then that water will flow easily through the pore spaces and can be absorbed by the grass plant roots.

- Always water the green first with approximately 800 -- 1000 litres to coat the particles to a depth of about 50 mm then apply the EM and follow up with another small application of water about 4-600 litres.  Note that once a particle is coated with "retained" water the rest of the water will flow freely through the pore spaces.

Before applying any substance to the green make sure that all the particles are coated with retained water.

# Ph. (potential Hydrogen)

**"Active pH" and "Buffer pH"**

Soil pH is a very important value to understand in the soil analysis report. The soil pH scale is measured from 0-14. A reading of 7.0 is the middle of the scale and is considered to be "neutral". Anything below 7.0 is acidic and anything above 7.0 is basic or alkaline.

Each movement of one whole number on the pH scale represents a change by a factor of 10. For example, several months after liming you noticed the pH moved from 6 to 7 on the pH scale. The move from 6 to 7 means the soil is now 10 times less acidic than it was at 6. A movement from 5 to 7 means it is now 100 times less acidic than it was at 5.

The letters "pH" means "potential Hydrogen". The soil analysis will record two different pH tests. They include the active pH test and buffer pH test. "Active" pH is the measure of hydrogen ions in the soil at the root zone. The more hydrogen that is present in the soil, the lower the pH number and the more acidic the soil is. The less hydrogen that is present translates to less acidity and a higher number on the pH scale. Active pH is the type measured with a home soil test kit.

The soil pH doesn't tell you anything about the soil composite or how much lime to apply. Unless you know already what the soil contains, all the soil pH will give you is the active pH. This will tell you that something may need to be done, but exactly how much lime is determined by other factors.

"Buffer" pH is performed in a lab and is the measure of the soil's resistance to change. Simplified, it means that heavier soils that are high in organic matter or clay will require more lime to correct acidity problems than sandy soils would require with the same pH reading. To explain further, a reading of 5 on the pH scale is the same for all types of soil. However, to correct the pH and bring it back to 7 would require differing amounts of lime depending on what elements are in the soil. That is what the buffer pH determines.

A home soil test kit doesn't test for buffer pH.

The only reason a soil test will give lime recommendations is to adjust the soil pH. No other reason. This means that the soil Ca Saturation may not be totally adjusted if much is needed.

If soil pH is not far off, but the soil Ca saturation is low, Calcium is needed.

**Material for correcting acidic soils**

Limestone is used to make soils less acidic and bring the pH number up. When applying lime, make sure you follow the soil analysis recommendations.

The best method is to roto-till the lime into the soil. For established greens, lime can be applied using a fertilizer spreader and distributed over the surface of the grass. It will, however, take much longer to affect the soil pH when spread over the surface. It must work itself into the soil.

"Hydrated lime" is the type that is used in cement and mortar. It is sometimes used on greens but has a very high burn potential and is not the best choice. Agricultural limestone is safer to use but works a little slower.

**Material for correcting alkaline (high pH) problems.**

If the soil analysis report shows that the soil is alkaline (above 7), Sulphur or aluminum sulphate is the best choice. Sulphur is an age-old product but may take months to be effective. Sulphur requires soil microbes to break it down first. Aluminum sulphate, on the other hand, works immediately and is what most greenkeepers use.

All these products can burn the grass, so water them in immediately after applying.

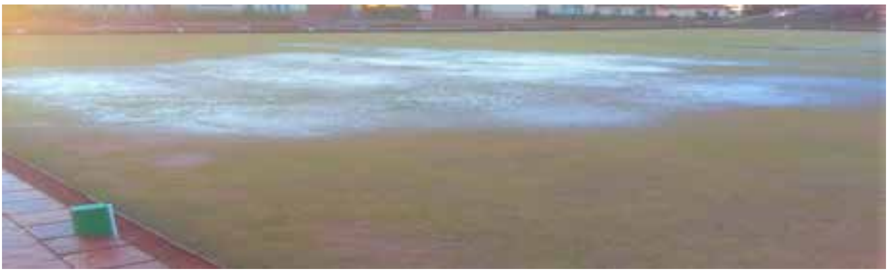
# LOCALISED DRY SPOTS

## CAUSES AND CORRECTIONS

The occurrence of severe localized dry spots in turf is seldom observed on greens.

**Several causes for localized dry spots have been suggested.**

1. One is the tendency for the thatch layer to dry out and become hydrophobic, it sheds water instead of allowing the water to wet the thatch and pass through.



2. In other cases, dry spots may be associated with poor water distribution such as:
   - Wind during irrigation, worn or damaged irrigation equipment, or the application frequency and intensity of irrigation.
   - Hand watering.
   - Soil variability or soil restrictions to rooting and water penetration. Infiltration rates can be limiting on sloping soils causing insufficient water. (Runoff)
   - Soil compaction.
3. Another cause may involve fungal activity in the soil. The fungal mycelia and products they give off are thought to cause a hydrophobic soil condition.

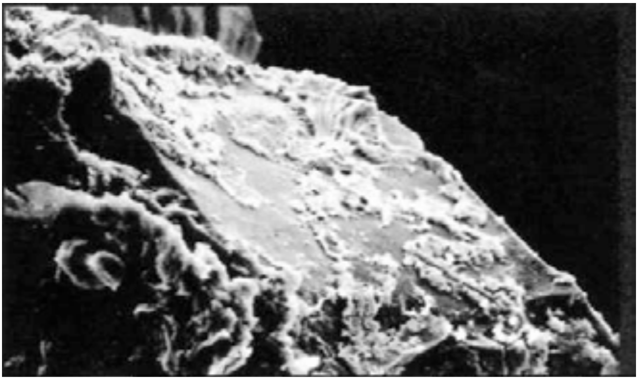
**CORRECTIONS**

Solutions for the localized dry spot problem depend on the cause. Improved water distribution and irrigation practices, thatch control, cultivation and wetting agents are usually suggested. Cultivation practices such as coring, or spiking must penetrate the hydrophobic soil layer so that water can penetrate.

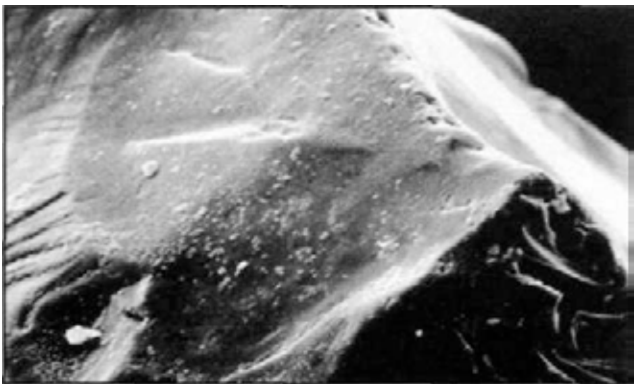
The organic coating results from the natural breakdown of organic substances such as roots, shoots, moss, or other organic soil amendments that may be part of the root zone mix. This is a normal microbiological process that occurs in all soils.

The coating, when very dry, is of a chemical nature that repels water, which, along with the inherent poor moisture-holding capacity of a sandy soil, predisposes the turf to extreme soil-moisture deficits. This condition can become so severe that normal irrigation practices are often ineffective in restoring adequate soil moisture.

This scanning electron microscope photograph shows a sand particle at a depth of 0 to 25mm from a localized dry spot.



In contrast, here is the same type of photograph of a sand particle at the same depth from a healthy area



**CAUSES OF DRY SPOTS**

Guides on grass management advocate a particle size analysis (PSA) as it influences many important physical and hydraulic properties of soils. The degree of porosity determines how easily water and air can infiltrate and permeate between the open spaces and how much water the soil will hold (specified yield). It is interesting to note that the size of a water and oxygen molecule is microscopic as compared to that of a small sand particle which is macroscopic.

Well-sorted medium sand with a similar and narrow range of sizes (0,3 – 0,8 mm) would have a potentially high infiltration rate and low degree of compaction. In comparison, poorly sorted soil mixtures (such as loam) which have a large range in particle textures extending from clay, silt, various sands to gravel have a potentially lower infiltration rate and higher degree of compaction.

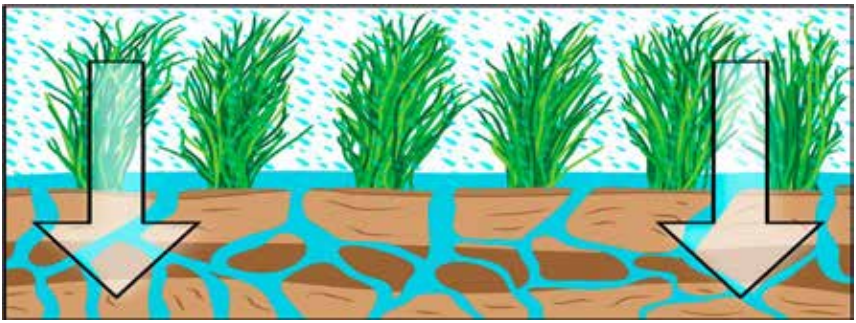
**INFILTRATION, PERCOLATION AND HYDRAULIC CONDUCTIVITY**

Waterlogging is a serious problem affecting many areas of agricultural land. Before we can correct the problem, we need to understand what is happening.

As waterlogging is due to restricted water movement through the soil, we need to understand the behaviour of water in the soil profile before we can identify the most appropriate course of action.

**Infiltration and hydraulic conductivity**

Both terms have been used to varying degrees to describe water movement in the soil. However, they are subtly different.



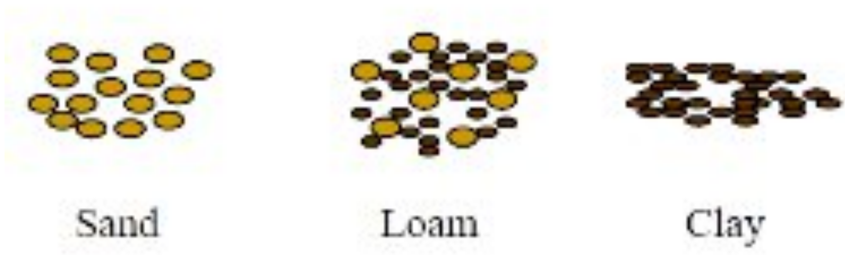
**INFILTRATION RATE**

The **infiltration rate** is the velocity or speed at which water enters the soil. It is usually measured by the depth (in mm) of the water layer that can enter the soil in one hour. An infiltration rate of 15 mm/hour means that a water layer of 15 mm on the soil surface, will take one hour to infiltrate.

In dry soil, water infiltrates rapidly. This is called the **initial infiltration** rate. As more water replaces the air in the pores, the water from the soil surface infiltrates more slowly and eventually reaches a steady rate. This is called the basic **infiltration rate**

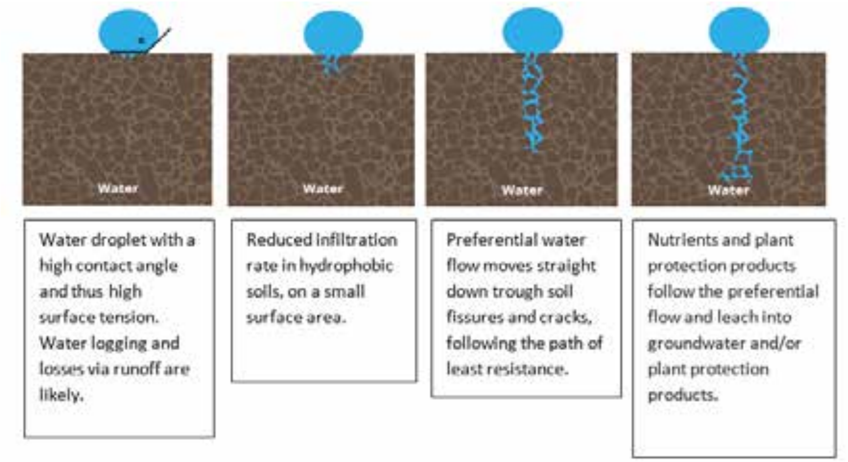
The infiltration rate depends on soil texture (the size of the soil particles) and the soil structure (The most common method to measure the infiltration rate is by a field test using a cylinder or ring infiltrometer.

**Hydraulic conductivity**
Is the infiltration rate plus other constraints associated with water movement through soil.
**Infiltration**
As infiltration refers to water entry into the soil, it is largely determined by the condition of the soil surface. The main influencing factors are sand, loam, clay:




The hydraulic conductivity of a soil is determined by soil profile characteristics. These include:
**Soil moisture**
If the soil already has a high soil moisture content, infiltration will be low, as most of the soil pores will already be filled.
**Soil structure**
Well aggregated soil promotes high infiltration rates as there are more 'gaps' for water to flow through. Excess cultivation can be detrimental to soil structure.
**Soil texture**
As mentioned previously, water will infiltrate into sand quicker than into clay. Water will also **move through** sands quicker than clays. However, the flip side to this is that sandy soils will not store as much water as clay soils – requiring greater inputs of water to maintain moisture contents.
**Soil management**
How the soil is managed has a large bearing on infiltration rates. As mentioned previously, cultivation can have a large impact on infiltration, as can the organic matter levels in the soil. Not only does organic matter help improve soil structure through promoting soil aggregation, but it also aids in 'trapping' water, and allowing it to infiltrate slowly. This is termed 'soil roughness' – basically stopping water from running off and pooling.
**Percolation**
Is the movement of water within the soil.
Percolation rate controls the infiltration rate.
Percolation in soils is primarily due to gravity pulling the water vertically downward.
The rate of percolation is controlled by grain size.

**Hydrophobic soil**




**USE OF WETTING AGENTS**

Frequent comments of a 'green-up effect' have been seen during greenkeepers user trials with wetting agents, where treated areas have responded with a rapid visual improvement in colour. A key factor in this is believed to be the enhanced uptake of nutrients, through a combination of greater immediate availability from better contact of soil moisture along the root and, over the longer term, increased retention of nutrients in the rootzone.

Where roots are growing in hydrophobic soils - or even small pockets of hydrophobicity within the soil profile - there will be lengths of the root that have little or no contact with soil moisture.

Where the use of a combination wetting agent creates a more even distribution of soil moisture in hydrophobic areas, and thereby along a greater length of the root mass, it should lead to a greater nutrient uptake. Even in a wet season, the issue of hydrophobicity can still lead to dry patches within the soil profile.

To achieve the desired even spread, you need to have the right sort of wetting agent.

It needs a combination of sufficient penetrant to move the water and achieve the spread along the roots and through hydrophobic soils, along with effective polymer retention of moisture right through the rootzone.

A conventional polymer wetting agent is unlikely to provide sufficient even distribution of moisture to achieve such a benefit.

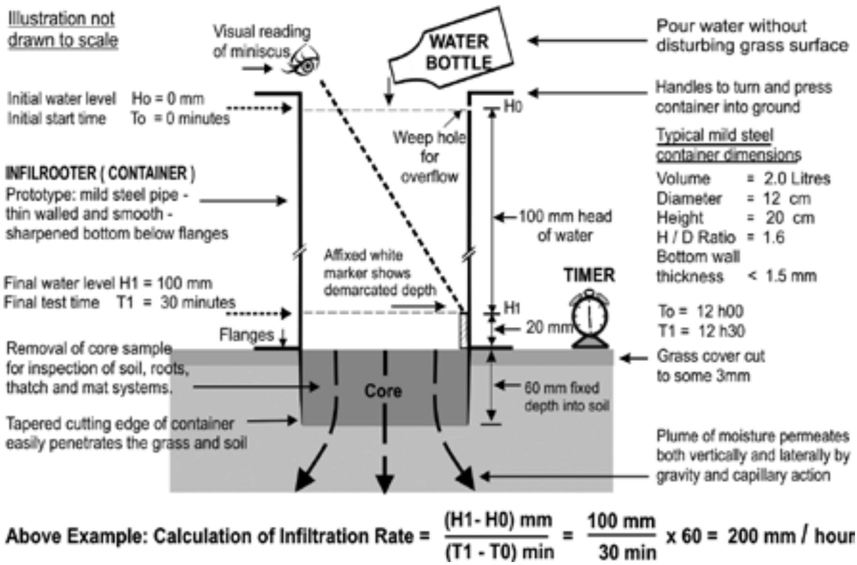
Secondly, with soil moisture being held more effectively deeper in the soil profile, there would be a reduced leaching of nutrients, which results in more available for root uptake and increasing the efficiency of fertiliser applications.

If we can better retain the root structure over the summer - through any combination of actions, including combination wetting agent programs, raising the height of cut, aeration, and irrigation it should also enhance overall plant health, minimise the energy requirement for root mass recovery in the autumn and give the turf plant greater carbohydrate reserves ready for the winter.

**INFILROOTER TO CHECK COMPACTION ON GREEN**

Compaction of manicured grass surfaces such as bowling greens, is a progressive and inevitable process caused by high player numbers and maintenance machines. For the health of the grass, compaction can be minimized by timeous aeration techniques.
A simplified and low-cost apparatus, termed the Infilrooter, enables both the measurement of water infiltration and subsequent withdrawal of a core sample for investigating the root-soil-grass systems.
The Infilrooter is a most basic apparatus with no mechanical, electrical, or chemical components. To function, it only requires water and a measurement of time. The Infilrooter measured water intake through the surface 0- to 60-mm depth zone under a falling head from 120 to 20 mm.
The need for aeration due to compaction is identified when the water infiltration rate becomes less than 100 mm per hour.

**INFILROOTER**



# DROUGHT MANAGEMENT

Drought management does not start when water restrictions are imposed. Although the greenkeeper normally knows well ahead that limited water restrictions followed by complete prohibition may be imposed within a certain space of time, he should always be aware of the possibility that a drought situation could be in the offing.
Where a Club relies on underground water for its needs the possibility that the supply might suddenly dry up must always be borne in mind.
During the months of November to March most of our grasses are in their prime growth. It is at this time where the use of our irrigation should yield the best results.
In RSA we are continually confronted with potential water shortages, therefore it is important to look at which role water plays in producing good greens.

**Planning drought management**

**Mowing**

Proper mowing techniques can make a big difference in whether your green is healthy and able to survive the stress of infrequent rains and water restrictions the objective would be to reduce those operations which increase stress in the grass plant while exposed to drought conditions.
With the onset of watering restrictions, the greenkeeper should immediately warn his members that he will be obliged to increase the mowing height by, at least, one millimeter. The increased leaf area would produce more CHO and at the same time reduce the stress on the grass plant and the defense mechanism.

**Irrigation.**

Having sufficient moisture in the root zone is the cornerstone to the health, growth, and survival of the grass plant.
With a deep, strong, and healthy root system the plant will be healthy, vigorous and more resilient.
Having sufficient water in the root zone is essential, one must not over irrigate as this will disrupt the balance of air and water in the soil. If the solid soil particles in the root zone constitute 50% then the remaining volume must be made up of 25% water and 25% air. When this balance is disrupted that the plant goes into stress mode.
To encourage a deep root system, one must irrigate depending on soil texture once or twice deeply. Loam soils once weekly and sandy soils twice weekly.
Use a rain gauge to measure how much water you are putting down and then determine how long you want your system to run.
Soil dries from the surface downwards, and under these conditions the roots will grow downwards into the soil towards the moisture. One must not encourage shallow root zone by under irrigating.

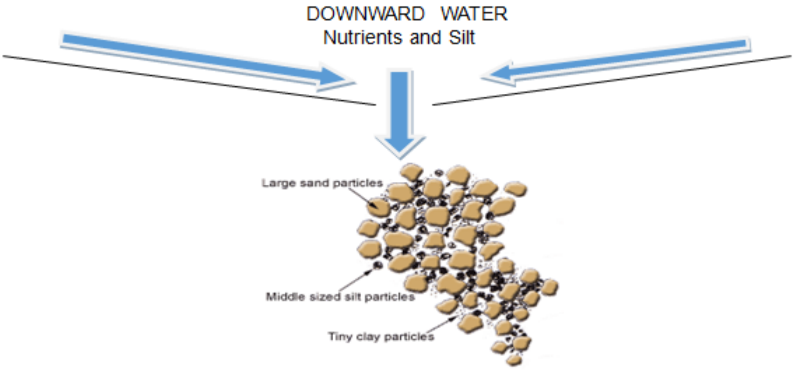
**Tips when to irrigate.**

The first signs of heat stress are wilted leaves, purple /grey or blue leaf colour and loss of resiliency. (Your footprint remains on the green when walking on the grass).
Dry spots may need more watering.

**Nutrition**

Avoid fertilises high in nitrogen (N) and Phosphates (P).
Fertilise with Potassium (K) as this will make the plant more resilient.
Use Kelp P or Seagrow to promote root development and so to optimise water uptake.

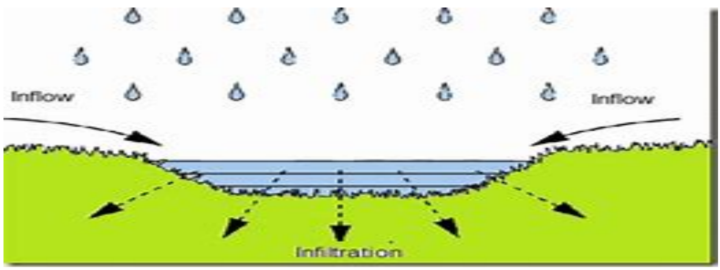
# UNLEVEL SURFACE




**WATER PULLS FINE SILT PARTICLES ALSO NUTRIENTS WITH IT TO LOWEST AREA CAUSING COMPACTION IN LOWER AREAS AND HIGHER AREAS TO HAVE NUTRIENT DEFIENCIES.**

**This is seen when green and dry areas are observed across the green. (Commonly known as Dry or Hotspots)**

**Flow of nutrients and water on unlevel surface**



# TURFGRASS FUNGUS AND DISEASE

**Introduction**

There are somewhere in the neighbourhood of 100 different diseases that affect turfgrasses. Just like human illnesses, each turf disease has a specific prescription for its cure and prevention. Some diseases can be suppressed by the application of nitrogen fertilizer, whereas others are encouraged by more nitrogen. Some diseases are suppressed by high soil pH, whereas others are encouraged by low pH.

As the older, broad-spectrum fungicides are removed from the market due to environmental concerns, they are being replaced with a new generation of products with narrow control-spectrums. These new products are very effective, and safe to the environment, but they are effective against a small number of diseases. Because of this change in the turfgrass industry, accurate diagnosis of turfgrass diseases is becoming even more important.

**IDENTIFICATION**

Turfgrass diseases are very difficult to identify. Grass plants are very small, and most diseases are caused by microorganisms that can't be seen without a microscope. However, with some basic knowledge and a lot of practice, you can vastly improve your diagnostic skills. By learning how to diagnose just a few common diseases, you will be able to diagnose most of the disease problems.

**What are the symptoms and signs?**

Most diseases leave a unique and reliable pattern on the turf.

Far too many greenkeepers attempt to diagnose diseases just by looking at the problem from a distance.

Symptoms observed on individual plants include *leaf spots, foliar lesions, stem lesions, foliar blight, foliar dieback, crown rot, and root rot.* A *leaf spot* is a round or oval area on the leaf with a distinct border, which is usually a different colour than the centre of the spot.

**DISEASES CAUSED BY THE FOLLOWING.**

| **LOW NITROGEN** | **HIGH NITROGEN** |
|---|---|
| • ANTHRACNOSE | FUSARUIM PATCH |
| • LEAF SPOT | NECROTIC RING |
| • RUST | PYTHIUM BLIGHT |
| • DOLLAR SPOT | LEAF SPOT |
| • TAKE ALL PATCH | YELLOW TURF |

**WEATHER CONDITIONS DO PROMOTE DISEASES**

| **WARM & WET** | **WARM & DRY** | **HOT & WET** |
|---|---|---|
| ANTHRACNOSE | NECROTIC RING | BROWN PATCH |
| DOLLAR SPOT | | SUMMER PATCH |
| LEAF SPOT | | PYTHIUM |

| **COOL & WET** | **COOL & DRY** |
|---|---|
| RED THREAD | RUST |
| TAKE ALL PATCH | STRIP SMUT |
| BROWN PATCH | LEAF SPOT |

**FUNGUS**

Many diseases occur on the different turfgrasses that are used throughout RSA. Most of the diseases are caused by fungi and nematodes. Some problems such as wilt, cold, heat, high soluble salts, soil compaction or chemical damage that resemble diseases are caused by environmental or management factors.
Careful identification of the cause of the problem is important when selecting proper control methods.
Susceptible plants, a favourable environment and a pathogen are required for a disease to develop.
Disease will not develop unless these factors are present at the same time over a certain length of time. Free water on leaves and optimum temperatures for a certain number of hours are required for most fungi to cause disease.
Chemicals are applied in a curative program after some disease is present. This method requires rapid identification of the disease, selection of proper chemicals and usually higher rates of the chemicals for control.

**Factors Affecting Disease Development:**
Spores survive in the soil and on thatch. The spores germinate and develop into a colourless slimy mass that grows over the soil and nearby plant parts during wet weather.
Reproductive structures are the small, coloured bodies that develop on leaves during the warm, wet weather.
Control: The slime moulds may be removed by brushing, mowing, or washing the turf.

**Factors Affecting Disease Development:**
The smut fungus grows rapidly in plants during cool weather (around 70 F), although plant death is hastened by temperatures of 85 to 95 F. High moisture favours spread of the fungus, but drought stress on plants causes them to die. Low fertility and acid soils favour disease development.

**A Fungus starts a disease.**

Most of us have seen mycelium growing on old bread or rotten fruit or vegetables and may have referred to these organisms collectively as moulds or mildew.

Fungi are the most common parasites causing plant disease. Most are microscopic (very small and can only be seen with the aid of a microscope) plants that feed on living green plants or on dead organic material. When they attack living plants, a disease result. Fungi usually produce spores *(MYCELIUM)* which, when carried to a plant, can begin an infection. These spores may be carried from plant to plant by wind, water, insects, and equipment. For fungus spores to begin new infections, adequate moisture and the right air temperature are required. A plant wound is sometimes also needed as an entry for the fungus. Fungus diseases are common during wet, humid seasons.

Bacteria are single-celled microscopic organisms. Some attack living plants and cause plant disease. Bacteria can be carried from plant to plant by wind, rain splash, insects, and machinery.

Mycelium

**Leaf Diseases Caused by Fungi and Bacteria**

No matter your skill level, you can look for these 5 things to tell if you have turf disease occurring.

**1. Fungal Structures:**
They vary in shape, colour, and appearance, but most turf fungi will have some sort of structure that can be seen when moisture is present. As the night-time dew settles, you'll be able to see these strange growths and structures in your grass.

**2. Matted or Collapsed Areas:**
Certain diseases will cause grass plants to wilt quickly. This, along with fungal structures, can leave the grass appearing matted or collapsed in some areas.

**3. Discoloured or Oily Areas:**
Greens will often contain multiple species and even cultivars of that species of turfgrasses. This means that some areas will show disease symptoms more than others. Unaffected turf may remain in its typical state when nearby areas may vary in colour as the leaf tissue is damaged. In some instances, certain diseases may create a darker hue on the grass.

*Spore masses* are fuzzy, or jelly-like growths produced on the diseased tissue by certain fungi, again usually when the turf is wet, or humidity is high.

**SPORE MASS**

*Sporophores* are enclosed structures that contain fungal spores. Often seen as small, dark specks on the diseased tissue

**SPOROPHORES**

#### 4. Spots or Lesions on Leaves:

Another key to identifying specific turf diseases is noticing the specific damage pattern on the leaf blades of the grass plants. Some spots may vary in colour, size, and placement on the leaf tissue.

**5. Residue on Shoes and Mower:**
Depending what fungi is present in the grass, you may notice strange powdery substances on shoes or on your mower. These will vary in colour as well as in time of the year it is present.
Hopefully these 5 things will help you to identify what disease is occurring on your green. Treatment recommendations will widely vary based on the specific disease on your green, so proper identification is crucial.

**NB - Find out what's going on with your green before it's too late!**

**Algae**
Algae are single-celled plants that grow on the surface of wet soils or in water. Algae may become
a problem in thin turf areas where the grass is thinner. Often a dark scum may appear on the soil surface. This scum may crack and curl during dry weather.
Control:
Algae can be controlled by coring or spiking to improve soil drainage. Also, copper sulphate, ferrous sulphate or JIK to control algae growth.

**Moss**
Moss occurs in lawns growing in acid soils having low fertility and poor drainage. Shading, overwatering, compacting or a combination of these can lead to moss problems.
Control:
Moss can be controlled by raking, improving fertility, and reducing the amount of shade.

**Conditions Favouring Diseases.**

- Combination of humid conditions and moist turf surfaces
- Poor drainage
- Excessive thatch
- Soil pH
- Excessive or Low levels of Nitrogen.

**Management**

- Moisture control
- Address drainage issues
- Regular aeration
- Thatch reduction

**Time of Disease**

| Name | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Causes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dollar Spot | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | ✓ | ✓ | Wet Weather, Dew<br>Low N Levels |
| Fairy Ring | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | Mushrooms appear<br>Wet Weather<br>Thatch |
| Spring Dead Spot | | | | | | | | ✓ | ✓ | ✓ | | | After Winter<br>Thatch |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pythium Blight | ✓ | ✓ | ✓ | ✓ | | | | | ✓ | ✓ | ✓ | ✓ | Hot Wet Weather<br>High N Levels<br>Poor Drainage<br>Thatch |
| Fusarium | ✓ | ✓ | ✓ | | | | | | | | ✓ | ✓ | Wet, Humidity<br>High pH,<br>High N Levels<br>Poor Drainage<br>Thatch |
| Nematodes | | | | | ✓ | ✓ | ✓ | ✓ | | | | | Dry Conditions |

# INSECTS & PESTS.

There are two species of insects that are found around our greens in the R.S.A., insects harmful to plant life and beneficial insects.

**Effective control**

To effectively control insects, it is important to understand them better. Because insects are cold-blooded, the outside temperature regulates everything they do. Their hard external skeleton (exo-skeleton) also becomes resistant to chemicals.

Their development or metamorphosis takes place in the following sequence: egg, nymph, and adult. For an insect to grow, it must shed skin (moult). Some pesticides disrupt this moulting process.

It is important to note that if you use IGRs when the insect is in the mature state, you are wasting time and money.

The three most important factors in insect control are:

- Selection of product.
- Technique
- Timing – most important.

There are two groups of insects:

- Above ground, e.g. caterpillars.
- Subterranean insects, e.g. mole crickets, Black Maize beetles.
- They are protected by the soil around them. It is difficult to get the insecticide to the subterranean insects. When the soil is dry, subterranean insects move down into the ground because they need a reasonable measure of soil moisture.
- If there is dry organic matter, the insecticide tends to stick to it.

**Underground**

There are two options:

- Heavily irrigate the area so that the grubs move up and then apply the insecticide and irrigate afterwards.
- Wait until you get good rain, because though the grubs are larger, they are then closer to the surface.
- Nematicides or Molasses (2lt) or Dark Brown Sugar (10kg) can be used as a curative if nematode assay results indicate nematodes are a problem, or as a preventative if nematodes have been a continual problem.

**Above Ground**

If you see a lot of moths flying around at dusk it is an early indicator that you will have caterpillars in a week or 10 days.

If there are a lot of birds on turfgrass it is an indication that there are caterpillars or worms.

Hadada's disturb the surface to get at the grub's underneath.

Black Maize beetles on surface.

**PESTICIDES**

**Storing pesticides**

Always store pesticides out of reach of children, pets and away from food or foodstuffs, in a locked cupboard or room. Never use any container other than the pesticide container, or problems could arise when not labeled correctly. The area of storage must be a well-ventilated area. Always write the date of purchase on the label because most pesticides have a limited shelf life and may be completely useless after a year or two.

**When making use of insecticides and fungicides on a regular basis microbe within the soil are destroyed and must be replaced with EM (Efficient Microbes).**

### How Pesticides Affect Soil Microbes

Pesticides include a large group of chemical agents that attempt to eliminate destructive biological forces in agriculture. These include herbicides for killing plants, insecticides for killing insects, fungicides for killing fungus and bactericides for killing bacteria. While these chemicals supposedly only target specific species, repeated use inevitably kills microbial life that is beneficial to the soil system. Microbes that survive can be genetically altered in a way that is no longer beneficial to the soil ecosystem and be resistant to the chemical intended to kill them. The destruction or alteration of first-level microbes can affect the entire soil ecosystem.

### Effects of Soil Microorganisms on Plant Health and Nutrition

Soil microorganisms, sometimes spelled as soil micro-organisms, are a very important element of healthy soil. Knowing what microbes in soil eat, the conditions they thrive in and the temperatures that they are most active in is important in organic gardening and organic lawn care. From a practical standpoint, it boils down to organic matter, but not just any organic matter. These facts below will help you plan your activities around the time they are most beneficial. Below is a partial list of important functions they perform.

Soil microorganisms are responsible for:

- Transforming raw elements from one chemical form to another. Important nutrients in the soil that are released by microbial activity are Nitrogen, Phosphorus, Sulfur, Iron and others.
- Breaking down soil organic matter into a form useful to plants. This increases soil fertility by making nutrients available and raising CEC levels.
- Degradation of pesticides and other chemicals found in the soil.
- Suppression of pathogenic microorganisms that cause diseases. The pathogens themselves are part of this group but are highly outnumbered by beneficial microbes.

Soil microorganisms are living, breathing organisms and, therefore, need to eat. They compete with plants for nutrients including Nitrogen, Phosphorus, Potassium, and micronutrients as well. They also consume amino acids, vitamins, and other soil compounds. Their nutrients are primarily derived from the organic matter they feed upon. The benefit is that they also give back or perform other functions that benefit higher plant life.

**STICKERS. (Used to sustain longer time for insecticide on plant)**

A sticker can perform three types of functions. It can increase the adhesion or "stickiness" of solid particles that otherwise might be easily dislodged from a leaf surface, sort of glue them on as it were.

It can also reduce evaporation of the pesticide. If the dried residue from a spray drop consists of one-half pesticide and one-half of some other chemical (on a molar basis), the partial molal vapour pressure of the pesticide will be reduced by one-half, and the evaporation rate will be accordingly diminished.

The third function can be to provide a waterproof coating. If a pesticide is fairly water soluble, it may be washed off the leaf during heavy rainfalls that follow.

Many of the stickers contain surfactants as their principal functioning agent and are sold as spreader-stickers, which give both a sticker action and a wetter-spreader action.

## NEGATIVE IMPACTS ON A BOWLING GREEN CAUSING A DECLINE.


The continuing cycle of events is the Circle of Decline in action and regardless of the agronomic damage, the disruption to play is the most important aspect for greenkeepers. Thatch build up is one of the most devastating features of this cycle and it kills the greens performance in 3 main ways.

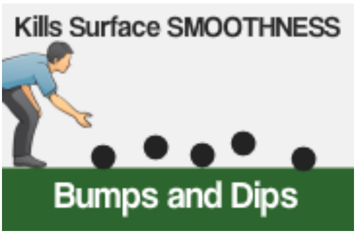
**Thatch and Green Speed**


Due to the spongy, soft nature of an excessive thatch layer, the energy needed to propel a bowl a set distance is increased significantly. The fibrous mat of thatch saps the energy from your shots making it difficult to play with any level of finesse or predictability. It essentially produces a surface that is unfairly inconsistent. It's a bit like playing on deep pile carpet, but trickier.

**Thatch and Green Trueness**


Excessive thatch builds up and tends to dry out unevenly, leaving dips and bumps on the green surface that will cause a bowl to veer off its course unexpectedly. The nature of thatch means that even if you could get a handle on this and play accordingly in your match, it will all be different tomorrow. Thatch is continually moving, shrinking, and expanding in response to the environmental changes in air temperature, soil temperature and moisture, weather, and relative humidity.
Thatch is the main cause of complaints about straight hands, bad runs, and dodgy rinks.

**Thatch and Green Smoothness**




Almost imperceptible dips, hollows, bumps, and gullies in the surface which move and change continually with weather and moisture changes are features of excessive thatch. Of course, this can cause quite a lot of disruption to your shot as it traverses the rink.
In addition to the sapping of speed and deviations in the direction of the shot, thatch causes vertical deviation of the shot due to bumpiness on the green surface

# TURF INJURY & REMEDIES

The cause of turfgrass damage is often difficult to determine if considerable time has elapsed between damage and diagnosis.
Damage is often blamed on disease or insects when there is no sound basis for such a diagnosis. A careful diagnosis involves analysis of climatic and environmental conditions, along with the management program followed.
It is important to know what fertilisers, insecticides, fungicides, or herbicides have been applied, the amounts used, and the time and method of application.

*Causes:*

- Mowing
- Chemicals
- Moisture
- Undesirable Plants
- Disease and Fungus
- Insects
- Soils
- Other Problems

**Mowing**

**Height of Cut** - Mowing is one of the most abused and least understood turfgrass management practices. Shorter mowing reduces leaf surface (the plant's food manufacturing factory) to such a degree that the plant may have to draw food from its root reserves to initiate new growth. Repeated defoliation reduces the root system, and the plant will be weakened and unable to cope with adverse conditions.

**Frequency of Cut** - Infrequent mowing, which has become increasingly common. This may shock plants, causing depleted root reserves and general weakening. Normally, no more than one-third of the total leaf surface should be removed at each mowing. Excessive clippings left on the turf may injure or kill turf by smothering it.
Hot, humid conditions under these clippings are ideal for disease development.

**Dull Mowers** - Turf may have a gray to brown cast following mowing. In most cases this discoloration can be attributed to dull rotary mowers, although reel-type mowers may cause the same kind of damage. Basically, the discoloration is due to tearing, splitting, or shredding of the tips of the grass blades. Always keep any mower sharp and properly adjusted.

**Chemicals**

**Fertiliser Skips** - Although fertiliser skips do not constitute actual damage, they do result in a very unsightly appearance. The fertilised area will be a brilliant green, whereas the unfertilised area may vary from pale green to a chlorotic yellow color. Since fertiliser materials seldom move laterally, every effort should be made to distribute the material uniformly over the entire area.

**Fertiliser Burn** - Any type of fertiliser may cause fertiliser burn if applied in excessive amounts or when grass blades are wet. Soluble forms of nitrogen and potash are most likely to cause serious burn. To avoid this problem, always apply fertiliser in recommended amounts when grass is dry, if at all possible, water thoroughly after application.

**Herbicide Injury** - Some weed killers used to control specific weeds may damage turfgrasses if applied at rates exceeding recommendations. Unfortunately, many people feel that if "X" grams of material per sq/m is recommended, "2X" of material per sq/m will do a better job. The result - turfgrass injury or death.

Always apply herbicides accurately at the manufacturer's recommended rate.

**Moisture**
Irrigation - Irrigating a turf area at a rate greater than the soil's infiltration capacity may have effects. This type of watering causes run-off and wastes one of our most expensive commodities - water
Turfgrasses may also be damaged by frequent light watering.

**Localized Dry Spots** - Dead or injured spots often develop in turf areas because of insufficient moisture, even though surrounding turf shows no drought injury. Sandy soil layers have a low water-holding capacity and dries out very quickly. In other cases, a large amount of thatch may act as a thatched grass roof preventing water infiltration into the soil.

**Soils**

**Soil Compaction** - Soils of poor physical condition or those subjected to play or heavy traffic (especially when wet) form an impervious surface layer which prevents water infiltration, aeration, and nutrients from reaching the roots.

Aeration machinery may be used when compaction present.

- 0 – 40mm - Hollow tine – (Remove core fill hole with 20% compost and sand)
- Below 40mm – Verti-drain to depth of 150mm.

**Thatch** - Layers of partially decomposed leaves, stems, and roots at the soil surface will build up over a period of years. Thatch decreases turfgrass vigor by restricting the movement of water, air, fertilisers, and pesticides into the soil. Roots are normally quite shallow under thatch conditions, increasing the danger of drought damage to the plant. Disease attacks may be accentuated by thatch accumulations.

Mechanical de- thatching equipment should be used.

# Notes

# Notes

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