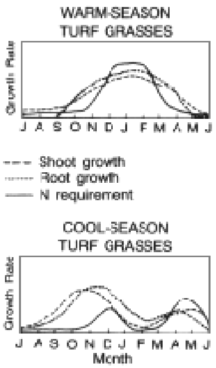
# fact sheet 44 Turf plant nutrition

FS44

Turf grasses are abused more than any other group of plants. They are repeatedly trodden on, crushed, and skidded over. As soon as they hold their heads high, a mower cuts them down to size again. After all this they must still look good throughout the whole year. To achieve this they are chopped with vertical mowers, spiked with coring machines, drenched with pesticides and supposedly selective herbicides, and deluged with water and fertiliser.

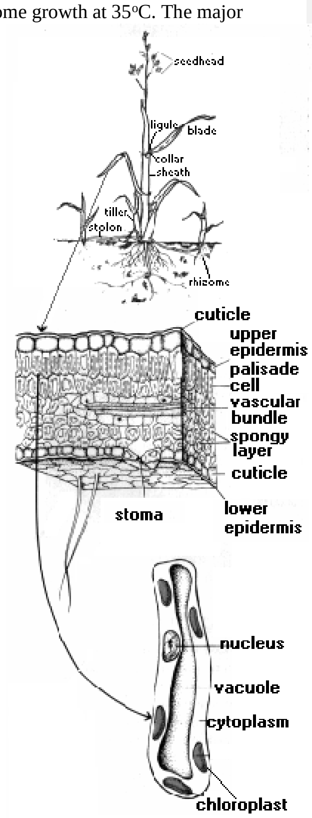
It takes some skill if these operations are not to do more harm than good. These skills are reinforced through a knowledge of the way turf grasses grow.

The grass family has a large number of members, which include many useful plants from sugar cane to wheat and barley and bamboo. Many turf grasses were originally introduced as pasture grasses to complement or improve our native grasses. Desirable features for turf is adaptability for a specific use, for example in a seaside area or for rough play; an ability to grow over a range of climatic conditions; have a high shoot density (plants per unit area); rapid recovery from wear and injury, tolerance to salinity, soil compaction, soil acidity, and heavy traffic; maintain good colour over a long season; and a low spreading growth so that it can successfully be mown.




Most turf grasses are perennials that go through annual cycles of growth but continue to live for many years. Turf grasses are divided into two groups, cool season grasses tolerate temperate to cold conditions, yet retain their greenness all year if watered in summer and if temperatures are not too high.. The optimum growth occurs within a temperature range of 15°-19°C. Root growth stops altogether when the soil temperature exceeds 23°C, so they tend to go dormant in summer.

Warm season grasses come from subtropical and tropical areas where rain falls all year or mainly in the warmest part of the year. Their optimum growth occurs in a temperature range of 23 to 32°C and there is still some growth at 35°C. The major differences between cool- and warm-season grasses is that warm-season grasses are much more efficient at utilising sunlight to make growth, and have significant advantages in terms of drought tolerance and water requirements.




A lawn area consists of individual grass plants in which the leaf sheaths are wrapped around one another in a stem-like appearance. The oldest leaves are to the outside of each plant and the youngest on the inside. These leaf blades normally extend until all cells at the base of the plant are mature. This process may take three to five weeks during which time the older segments of the leaf are often removed by mowing. When turf grasses branch out, they produce tillers or shoots, which emerge from axillary nodes between the leaf sheaths. Tillering and leaf emergence are the two significant aspects of the growth of turf grasses that influence turf density and how well it performs under local conditions.

Many turf grasses have a tufted, upright habit of growth, or else they have a spreading characteristic. The spreading nature is attributed to the development of stem growth which may extend under the ground (rhizomes) or run along the surface (stolons). Maximum rates for rhizome and stolon development occur when favourable conditions exist. Their development is minimal during periods of drought, heat, and low temperatures. Management techniques such as mowing, watering and fertilising also influence growth and development

**What goes on inside**

With a microscope we can see that plants are made up of thousands of cells joined in regular and beautiful patterns. There are many different types of cells, each having its own special function. The green colour of the grass is due to a pigment, chlorophyll. Given the right conditions, the chlorophyll present in the cells of every living leaf can convert or 'fix' carbon dioxide from the air into solid carbon compounds that the plant uses for energy and growth. This process is called photosynthesis.

Photosynthesis only takes place in daylight and ceases each night. Therefore the process requires light, abundant water, largely provided by the plant root system, carbon dioxide gas from the atmosphere and chlorophyll. These ingredients combine to produce sugars.

$$\text{carbon dioxide + water} \xrightarrow[\text{chlorophyll}]{\text{sunlight}} \text{sugars + oxygen}$$

Some sugars are used to make the cellulose of cell walls. These are structural carbohydrates. Once formed they cannot be converted back into sugars for use elsewhere in the plant.

When there is more than enough sugar for current needs, some is converted into carbohydrates called starches and fructosans, often termed storage or reserve carbohydrates. They can quickly be broken down into sugars again when more are needed.

Reserve carbohydrates are stored mainly in roots, stem bases, rhizomes and stolons. A moderate level of reserve carbohydrates are essential if turf grasses are to be able to meet any unexpected need. Reserves rise and fall throughout the year, and from day to day. They build up when photosynthesis produces more carbohydrates than are needed for current growth. In cool season grasses this occurs when days are mild (12-15$^{o}$C) and nights cool (7-10$^{o}$C). Temperatures a little higher than this produce growth, rather than storage. Even higher temperatures stress cool season grasses and reserves fall. The cycle for warm season grasses is about 5$^{o}$C higher.

Reserves are built up naturally in the weeks before the grasses go into dormancy because of falling temperatures.

**Carbohydrates and turf management**

The importance of carbohydrate reserves to turf management practices may be seen in the following examples.

Mowing reduces part of the ability of the plant to produce sugars. Reserves will be drawn on for a couple of days. If there are no reserves the grass will be weakened.

Removal of a high proportion of top growth at one mowing will severely drain reserves, leaving little for any other emergency such as a burst of hot weather. If cutting height is to be reduced, it must be done gradually.

Never remove more than one third of the total green growth at one mowing.

Grass that is repeatedly cut close must be managed carefully as reserves cannot be high. Short tops tend to have sparse root systems, especially in cool season grasses.

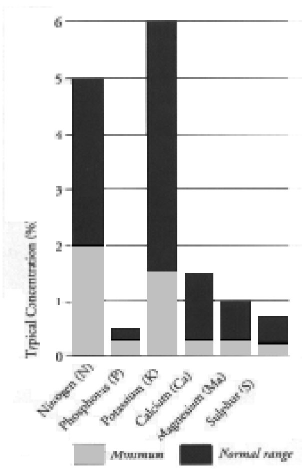
Encouraging top growth by applying large amounts of nitrogen will severely drain carbohydrate reserves. The plants may not cope with any extra demands such as very high or very low temperatures or an inadequate supply of water.

Carbohydrate reserves are generally low in heavily shaded turf. It should be cut higher to give more leaf area that can catch a little more light.

Renovation operations such as intense scarifying and coring place heavy demands on reserves. Only perform these operations at times of the year when new growth will use products of photosynthesis rather than reserves.

Hot weather reduces carbohydrate reserves. Cutting high will aid survival, as will eliminating nitrogen applications.

## The essential nutrients




The effects fertilisers have on turf are fairly predictable. What is unpredictable is the variation in climate, soil, grass species, past applications and irrigation water applied that means that each area of turf must be fertilised according to local conditions.

The simplest strategy of managing turf nutrition is to supply the turf with adequate levels of all nutrients except nitrogen. Growth is then controlled by application of nitrogen at appropriate times. Potassium supply should match the amount of nitrogen applied.

Reduced growth and paleness are the two main symptoms of poor nutrition. The turf will look sparse and weak when deficiencies are severe Paleness is most likely from deficiencies in nitrogen, sulphur or iron. Simple tests can show if the cause of turf paleness is due to a nutrient deficiency.

Plants lacking nitrogen or sulphur are pale green to yellow.. To check, apply urea (9 g/m$^2$) or ammonium sulphate (19 g/m$^2$), which will apply 4 g/m$^2$ of nitrogen as the pure element. The only difference is the sulphur applied in the ammonium sulphate. If both areas green up equally, the paleness is due to nitrogen deficiency.

If the area treated with ammonium sulphate greens up in a day or so and the other doesn't, then the turf is deficient in sulphur. If neither green up, or they look even worse, then the paleness has some other cause. Deficiencies of manganese, molybdenum, magnesium, boron and iron all give pale grass.

Symptoms of iron deficiency are fairly easy to recognise The youngest leaves become pale, then yellow to white, sometimes tinged pink. In the early stages, veins stand out sharply in green. If you are unsure, apply a solution containing 3 g/litre of ferrous sulphate (sulfate of iron). You will have an answer if the grass greens up overnight, otherwise search for another cause.

An application of 5 g/l of manganese sulphate will give rapid greening if the deficiency is manganese. Likely only on alkaline (limestone) soils.

**The essential nutrients**

| Element | Form in which absorbed by plants | Approximate concentration in whole plant (% of dry weight) | Rate/year per m$^2$ | Function |
|---|---|---|---|---|
| Nitrogen | $NO_3^-$ or $NH_4^+$ | 1 - 4% | as little as needed 10-20g | Key element in turfgrass nutrition<br>Vigorous stem & leaf growth<br>Component of amino acids (the building blocks of proteins), In the genetic coding material of chromosomes, chlorophyll,<br>coenzymes (vitamins) |
| Potassium | $K^+$ | 0.5-6% | 7-15g | Used in large quantities, second to nitrogen<br>Formation of carbohydrates (food for the plant)<br>Involved in osmosis and ionic balance (the flow of plant juices)<br>Opening & closing of stomata.<br>Regulating stem extension.<br>Activator of many enzymes.<br>Cell wall thickening (wear tolerance) |
| Calcium | $Ca^{++}$ | 0.2-3.5% | only when very acidic | Normal cell division.<br>Component of cell walls.<br>Enzyme cofactor.<br>Cell membrane permeability<br>Root growth |
| Phosphorus | $H_2PO_4^-$ or $HPO_4^{--}$ | 0.1-0.8% | 12 ppm<br>Fescue 0<br>Clover 2g | Energy transfer in photosynthesis (ATP, ADP)<br>Component of phospholipids, nucleic acids, coenzymes |
| Magnesium | $Mg^{++}$ | 0.1-0.8% | on sand when K used often | Part of chlorophyll molecule<br>Activator of many enzymes<br>Translocation of phosphorus |
| Sulphur | $SO_4^{--}$ | 0.05-1% | on alkaline soil only | Component of some amino acids, proteins, coenzyme A (oxygen utilisation) |
| Iron | $Fe^{++}$ , $Fe^{+++}$ | 25-300 ppm<br>1% = 10,000 ppm | 1g | Chloroplast development (photosynthesis).<br>Component of cytochromes, nitrogenase<br>Growth regulation |
| Copper | $Cu^{++}$ | 4-30 ppm | 0.7-1.4g as sulphate | Activator of some enzymes |
| Manganese | $Mn^{++}$ | 15-800 ppm | | Activator of some enzymes.<br>Oxygen release in photosynthesis |
| Zinc | $Zn^{++}$ | 15-100 ppm | 0.1-1.4g as sulphate | Activator of many enzymes<br>Production of growth hormones (auxins) that control stem elongation, leaf expansion, formation of roots |
| Molybdenum | $MoO_4^{--}$ | 0.1-5 ppm | | Required for nitrogen metabolism<br>Conversion of atmospheric N by bacteria |
| Boron | $BO^{---}$ borate<br>$B_4O_7$ tetraborate | 5-75 ppm | | Influences $Ca^{++}$ utilisation<br>Formation of cell walls during rapid growth |

CURTIS H, 1983. Biology. Worth Publishers Ltd, New York
HANDRECK K, 1993. Gardening down-under. CSIRO

**Phosphorus**

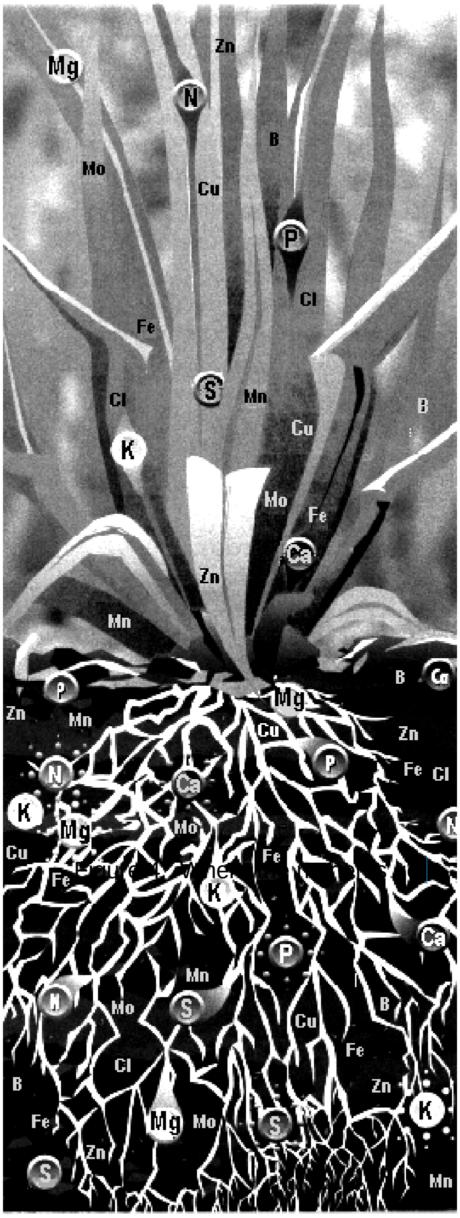
In healthy green leaf tissue, the Phosphorus/Nitrogen ratio is 6-15%. The total amount of nitrogen in leaf tissue is 3-4%. So the amount of phosphorus required by the plant is only 1/10% of the total weight of the plant. Expressing this in more familiar terms, A full wool bale of lawn clippings contains about half a cup of phosphorus. As fertiliser, it would have to be spread very very thinly over the lawn area you just cut, and this is sufficient to meet the plant's total annual requirement.

Surveys some years ago showed many lawns had levels of phosphorus well above the optimum, due to repeated applications of mixed fertilisers containing more phosphorus than is needed. The recent practice is to have P/N ratios near 0.06-0.15 as is found in healthy grass shoots. (ie. the Phosphorus level is 6%-15% of Nitrogen present in the leaf tissue.) Generally, existing P levels are adequate in established lawns.

High levels of phosphorus waste money. More importantly they may aggravate iron deficiency and encourage the growth of weeds, particularly *Poa annua.* Research has shown that the proportion of *Poa annua* increases as soil phosphorus levels increase.

**Commented [MGA12]:** TurfCraft May 1999 66:26 P < 10ppm

Fescues dislike even quite small amounts of phosphorus. They quickly die out when application rates of more than 1kg/1000m$^2$ of superphosphate are used




As a general rule, fine leaved grasses require less phosphorus than do those with broader leaves.

Clippings annually remove about 4 g/m$^2$ from very vigorous turf. Losses from most lawns will be much less than this, and annual applications should never exceed this value.

Clover grass lawns will require 30 g/m$^2$ of superphosphate annually (equivalent to 2.5 g/m$^2$ of Phosphorus).

**Calcium**
Calcium deficiency is only possible if the soil has become very acid. Where the pH is maintained at 5.5 or above and if gypsum is applied, calcium deficiency can never occur.

**Magnesium**
Most soils have an adequate supply of magnesium, and is most likely to occur on sandy soils when potassium is applied often. Finely ground dolomite is the best source of magnesium if soil pH has also to be raised, otherwise use magnesium sulphate (epsom salts) in a typical application of 45 g/m$^2$.

**Iron**
Iron is the trace element most commonly in short supply in turf soils. The symptoms are characteristically yellowing of the grass. Deficiencies are associated with high soil pH, excessive application of phosphorus, manganese, copper, and zinc, waterlogging, and excessive thatch.

The deficiency is easily overcome by spraying a 3 g/litre solution of ferrous sulphate (sulfate of iron) applied over 3 square metres. Do not irrigate until the next day, so the leaves have an opportunity to absorb some of the iron. Concrete paths will be stained brown. Don't be tempted to use very high rates in the belief that you can reduce application frequency. Fe can cause severe blackening to some grasses, including Kentucky bluegrass.

There is some evidence that overcoming iron deficiency can reduce the amount of nitrogen needed by as much as 30%.

**Potassium**
Potassium is particularly valuable for turf because

It encourages thickening of cell walls in grass leaves. This toughens them so that they are more wear resistant. Thickening of cell walls also makes them more resistant to diseases.
It promotes the storage of carbohydrates. Extra potassium applied just before dormancy will help grasses survive and enhance their ability to grow quickly after dormancy.
It increases the grasses tolerance to heat, drought, and cold.
Optimum levels of potassium ensure maximum root growth.

In sandy soils, continued applications of potassium may eventually produce magnesium deficiency, with yellowish, stunted growth symptoms. This can be corrected by: applications of dolomite at 10 g/m$^2$ if the soil pH is less than 5.5. Should pH be greater than 5.5, use 10 g/m$^2$ of magnesium sulphate (epsom salts), but this may cause salinity problems.

**Nitrogen**
If turf is well supplied with other nutrients, its growth can be regulated by the amount of nitrogen applied. More nitrogen gives more shoot growth and a greener, lusher turf, less nitrogen gives reduced shoot growth, sparse coverage and pale turf.

The aim of growing turf is **not** to get maximum growth, but to provide a surface and appearance that is acceptable to users. Trying to get maximum growth is costly, wastes resources, makes unnecessary work and can ruin the grass.

The amount of nitrogen needed per month of growing season ranges from 2-6 g/m$^2$. Domestic lawns will have an acceptable appearance with annual applications of nitrogen at a rate of 12-20 g/m$^2$ spread over 5 or 6 applications.

**When to apply fertiliser**
Nitrogen is applied when extra turf growth is needed, if seasonal conditions allow that growth.

The amount applied depends on the quality of turf that is desired. Is it to be lush and emerald green, or could it be maintained in acceptable appearance with minimal work.

Generally 3-4 applications made over the active growing season will provide an acceptable appearance. High quality lawns that are intensively managed should have applications every 4-6 weeks.

Be aware that fertilising dormant grass will only encourage weed growth.

For warm season grasses, N is applied from soon after the break in dormancy in spring, until late summer.

Any attempt to stimulate early spring growth with large applications of N may damage the turf. Early spring greenup is best achieved through a light application of N in late autumn, when the plant is producing reserve carbohydrates. Use a fertiliser with a N:K ratio of 1:2 applied at about 2.5 g/m$^2$ (eg Potassium nitrate with an N:P:K of 13:0:38 at 2kg/100m$^2$ or 20 grams per square metre). Timing is important. The application should be no later than 30 days before the first frost or very cool night is likely.

Cool season grasses grow most rapidly in autumn and spring and slow down in winter. In summer they will continue to grow with copious irrigation, but in hotter areas they tend to become dormant.

Little or no nitrogen should be applied in the hottest weather. The large flush of growth produced in early spring should not be further stimulated. Apply 2.5 g/m$^2$ of N in mid spring, decrease the rate in late spring; don't apply any fertiliser in early summer. Apply 1 g/m$^2$ in mid-summer and again during late summer. During the active autumn growth, apply a total of 5 g/m$^2$ over several applications two or three weeks apart.

Organic gardeners prefer not to use manufactured products, believing them to be harmful to soil organisms, to food crops, and to ourselves.
Irrespective of whether plant nutrients are derived from organic products or from a 'chemical' fertiliser,

**all fertilisers are chemical**.

Plants take up nutrients from the soil around their roots in the form of ions, such as nitrate ion ($NO_3^-$), ammonium ion ($NH_4^+$), phosphate ($PO_4^{-}$), potassium ($K^+$), etc. These ions are no different whether they have come from a 'chemical' fertiliser or from an organic fertiliser.

The content of available major nutrients in organic and 'chemical' fertilisers are both chemical.

The usefulness of organic fertiliser in intensive plant production (home gardens and lawns) is limited by the enormous variation in composition. You cannot be certain what the nutrient level in poultry manures is without testing. In some cases, the high concentration of ammonia in poultry manures can harm plants by ammonium toxicity. Many composted materials have such low concentrations of nutrients that they cannot supply sufficient nutrient fast enough to sustain rapidly growing plants. Repeated heavy applications of poultry manure will add excessively high amounts of phosphorus to a soil that will produce an imbalance in the same way that repeated application of superphosphate could produce. Overuse of an organic fertiliser will damage soil and plants just as surely as overuse of a 'chemical' fertiliser. Some poultry manure can be excessively alkaline because of the shellgrit eaten by the birds.

However, organic and 'chemical' fertilisers can complement one another. The amount of humus produced from organic wastes in a compost heap is limited by the amount of nitrogen present. More humus will be formed from organic mulches by adding ammonium sulphate (sulfate of ammonia) at a rate of 10-20g per square metre.

**Calculations**:

Fertiliser application rates are given in grams per square metre ($g/m^2$) of the pure element, nitrogen. To find the amount of fertiliser needed, use this formula:

Amount of mixed fertiliser needed = Lawn Area ($m^2$) x application rate ($g/m^2$) x 100 / concentration of Nitrogen (from NPK ratio on fertiliser label)

*Example*: Amount of Pivot 4 needed = 100 $m^2$ x 2.5 $g/m^2$ x 100 ÷ 15.5%
= 1613 grams = 1.6 kilograms

This result is expressed in grams (Divide by 1000 to get the number of kilograms)

*Example*: Amount of Potassium Nitrate needed = 100 $m^2$ x 2.5 $g/m^2$ x 100 ÷ 13%
= 1923 grams = 1.9 kilograms

For couch grass, the amount of nitrogen needed per month of growing season ranges from 2-6 $g/m^2$. Domestic lawns will have an acceptable appearance with annual applications of nitrogen at a rate of 12-20 $g/m^2$ spread over 5 or 6 applications.

To fertilise 100 sq metres of couch grass
with an application every 6 weeks from September to April through the growing season.
Annual application of nitrogen at 18 $g/m^2$ equals 3 $g/m^2$ at each treatment.
Amount of fertiliser required = 100 sq m x 3$g/m^2$ x 100 / 15% = 2kg (20g Pivot 4 per sq m)

If you only fertilise twice per year, for an annual dose of 18 $g/m^2$ of nitrogen, you will require
100 sq m x 9 $g/m^2$ x 100 / 15% = 6kg of Pivot 4 per application. Cost is $3.36
Using Complete D you would need 100 x 9 x 100 / 8% = 11.3kg Cost is $5.45
Which is more economical?

| **Fertiliser** | **N:P:K (%)** | **Amount required for 100 $m^2$ lawn** | | | **N/K ratio** | Approximate cost per 100 $m^2$ |
|---|---|---|---|---|---|---|
| | Application rate<br>Number / year | **at 1 $g/m^2$ N**<br>monthly | **at 2.5 $g/m^2$ N**<br>6 / year | **at 5 $g/m^2$ N**<br>3 to 4 / year | | **at 2.5 $g/m^2$** |
| Ammonium sulphate | 26 : 0 : 0 | 0.38 kg | 0.96 kg | 1.92 kg | 1 : 0 | $0.42 |
| Pivot No4 for lawns | 15.5: 0.2 : 7 | 0.65 kg | 1.61 kg | 3.23 kg | 1 : 0.45 | $0.84 |
| Potassium nitrate | 13 : 0 : 38 | 0.77 kg | 1.92 kg | 3.84 kg | 1 : 2.9 | $1.45 |
| Pivot Mineral Mixture | 10.5: 1.8 : 5 | 0.95 kg | 2.38 kg | 4.76 kg | 1 : 0.48 | $1.20 |
| Pivot Complete D | 8 : 3.6 : 7.9 | 1.2 kg | 3.12 kg | 6.25 kg | 1 : 0.98 | $1.56 |
| Pivot Special Lawn | 8 : 2 : 6 | 1.25 kg | 3.13 kg | 6.25 kg | 1 : 0.75 | $1.23 |

Note: the Phosphorus content of Mineral mixture, Complete D and Special Lawn may encourage wintergrass. Tall fescues do not tolerate Phosphorus, even in very small quantities. For these reasons the use of these garden fertilisers is not recommended for turf.

REFERENCE

ALDOUS D, 1991. Lawn care and lawn alternatives. Lothian Books
CURTIS H, 1983. Biology. Worth Publishers Ltd, New York
HANDRECK K, 1993. Gardening down-under. CSIRO
HANDRECK K A and BLACK N D, 1994. Growing media for ornamental plants and turf. University of NSW Press
SPENCER J, 1995. Fertiliser: a review. Golf & Sports Turf Australia 3(5):33-37