7.1 Introduction

A fertiliser is any material, organic or inorganic, natural or synthetic, that is added to soil to supply one or more nutrient elements. Because of intensive cropping, soil fertility can only be maintained by the addition of fertiliser.

Fertiliser can be in a number of different forms. The more important division is between not natural versus man-made, but organic and inorganic. Organic fertilisers have the macronutrients – especially the key three N, P and K – but also organic matter which enriches the soil. Inorganic fertilisers, which are generally more processed, only provide the macro- and micronutrients.

Inorganic fertilisers

For most inorganic fertilisers, which are a mixture of salts of the various nutrients, the N:P:K grade is an important measure. This is simply the %w/w of the three elements (with P expressed as P₂O₅ and K expressed as K₂O). For example, a fertiliser with a grade of 10-6-8 is composed of 10% N, the equivalent of 6% P₂O₅ and the equivalent of 8% K₂O.

The fertiliser does not actually contain these forms of P and K; they are simply the standard way of reporting their levels. It is like the reporting of water hardness as mg CaCO₃/L even though there is no calcium carbonate as such in the water.

To convert between the actual (total) and reported (grade) for levels of P and K, use the following factors.

\[
\begin{align*}
\text{Fertiliser Grade} & \quad \times 0.44 \\
\%P & \quad + 0.44 \\
\%K & \quad + 0.83 \\
\end{align*}
\]

**FIGURE 7.1 Conversion factors for P & K**

**CLASS EXERCISE 7.1**

A fertiliser has a grade of 14.1-8.2-10.3, What are the actual levels of N, P and K?
TABLE 7.1  Plant fertiliser composition (as %w/w)

<table>
<thead>
<tr>
<th>Element</th>
<th>General purpose</th>
<th>Slow release</th>
<th>Soluble</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen (as ammonium)</td>
<td>5.0</td>
<td>10.5</td>
<td>3.6</td>
</tr>
<tr>
<td>Nitrogen (as nitrate)</td>
<td>-</td>
<td>7.5</td>
<td>8.8</td>
</tr>
<tr>
<td>Total nitrogen</td>
<td>5.0</td>
<td>18.0</td>
<td>15.0</td>
</tr>
<tr>
<td>Phosphorous (water soluble)</td>
<td>4.3</td>
<td>4.3</td>
<td>4.0</td>
</tr>
<tr>
<td>Phosphorous (citrate soluble)</td>
<td>0.9</td>
<td>0.5</td>
<td>-</td>
</tr>
<tr>
<td>Phosphorous (citrate insoluble)</td>
<td>0.3</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total phosphorous</td>
<td>5.5</td>
<td>4.8</td>
<td>4.0</td>
</tr>
<tr>
<td>Total potassium (as potassium chloride)</td>
<td>4.1</td>
<td>9.1</td>
<td>26.0</td>
</tr>
<tr>
<td>Sulfur (as sulfates)</td>
<td>11.5</td>
<td>4.0</td>
<td>-</td>
</tr>
<tr>
<td>Calcium (as superphosphates)</td>
<td>12.2</td>
<td>0.96</td>
<td>-</td>
</tr>
</tbody>
</table>

* note that the (as xxx) simply means the chemical form, not the form as indicated by the %.

CLASS EXERCISE 7.2

What are the grades for these three fertilisers?

<table>
<thead>
<tr>
<th>Element</th>
<th>General purpose</th>
<th>Slow release</th>
<th>Soluble</th>
</tr>
</thead>
<tbody>
<tr>
<td>N grade</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P grade</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>K grade</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The levels of the nutrients varies greatly, depending on the intended use for the fertiliser. General purpose fertilisers often contain only the macronutrients (and most will not have magnesium). There are many different fertilisers designed for particular applications:

- **complete** – have the full set of macro- and micronutrients,
- **trace element mixture** – micronutrients only
- **specific plants** – formulations for plants requiring nutrients in different proportions to normal, e.g., rose, citrus, azalea & camellia)
- **slow release** – have a special organic coating on the fertiliser granules. The coating slowly decomposes, allowing a gradual release of the fertiliser over a number of months. This reduces the need for careful attention by the gardener, but importantly provides a steady flow of nutrient to the soil, rather than a major burst, then nothing
- **soluble** – all components are soluble, providing a quick tonic for plants, but one that is readily lost by leaching; ideal for pot plants and flowering plants; these tend to be high in nitrogen (above 25%) to give the extra boost in growth

The distinction between the different forms of the particular nutrients – ammonium vs nitrate for N, water soluble vs citrate soluble/insoluble for P – is important because of the different availability of the various forms. Citrate solubility for phosphorous is a measure of the solubility in a solution of neutral ammonium citrate, which presumably is supposedly to be a simplified representation of soil solution.
Nitrogen industrially is fixed by a chemical reaction from N\(_2\) to ammonia. From there, it is converted into ammonium by acidification, usually with nitric acid, to give ammonium nitrate, which has the two useful forms of nitrogen for plants. The sulfate and phosphate forms are also used in fertilisers. All ammonium salts are very soluble. One other form of nitrogen in fertilisers is urea (\(\text{NH}_2\text{CONH}_2\)), which slowly decomposes in the soil to form ammonium. This of course is generally converted to nitrate before uptake.

Phosphorous is primary available from large deposits of phosphate rock, which is essentially mineralised bird and bat faeces. Some South Pacific islands, like Nauru, are almost completely composed of this rock. The mineral phosphorous is very insoluble, and essentially useless as a fertiliser. It is processed by treatment with phosphoric acid into **triple superphosphate**, which is calcium dihydrogenphosphate. This is water-soluble, with a fertiliser grade of 0-45-0. Ammonium phosphate, formed by the reaction of ammonia with phosphoric acid has a grade of 10-34-0.

Potassium is present in fertilisers as the chloride salt, which is produced either from wood ash treated with hydrochloric acid, or from mineralised salt deposits.

Large scale fertilising of farms is often done by application of single nutrient fertilisers, while mixed fertilisers, which are more expensive, are more commonly used on smaller-scale plots. Mixed fertilisers are normally granulated with clay during processing to keep them from absorbing water and from clumping together.

**Organic fertilisers**

Natural material, principally manure, is both a **mulch** – a slowly decomposing organic cover over the soil to retain moisture – and a source of nutrients. The grade of fresh animal manure is typically around 10:5:10, but after drying, this will increase somewhat. Poultry manure tends to be much higher in nitrogen than cow manure, as shown in Figure 7.2. The addition of organic matter to the topsoil is probably as important in manure fertilising as the provision of elemental nutrients. It is something that the synthetic inorganic nutrients cannot do.

It is common for a natural fertiliser to be processed to some extent before use. This is often for reasons of safety – the risk of disease being spread by animal waste – or contamination – especially by weed seeds. Two important examples are “Dynamic Lifter” (granulated chicken poo) and “Blood and Bone” (as the name implies).

Wood ash is often used for fertilising soil. It contains a high proportion of potash – potassium carbonate – and is therefore a good source of that element, but is strongly alkaline, and may cause problems with overuse.

![Figure 7.2: Fertiliser grades for animal manures](image-url)
7.3 Fertiliser use

Overuse of fertilisers by commercial farming activities has led to pollution of groundwater and surface water through leaching of excess nutrients. The major problems are N and P, which have led to algal blooms, toxic algae and eutrophication. In a small scale garden, the levels recommended on the fertiliser packaging are simple enough to follow, and unlikely to cause problems, but the application of fertiliser to large farming areas must be planned more carefully.

Soil sampling and testing is an obvious need, especially where fertility problems are suspected or obvious. The problem of available versus bound levels of nutrients, especially with phosphorous, makes the results of testing difficult to convert into kg of fertiliser per hectare, and the type of crop also needs to be taken into account. Computer programs exist to take all possible factors into account.

Timing of the fertiliser application is also important. This is particularly the case for nitrogen, which is readily lost if not immediately used. The most appropriate time for nitrogen application is the plant moves into its main growth cycle. However, if the plant is moving towards flowering of fruiting, then nitrogen is the last thing it needs, because it will only encourage leaf growth.

What You Need To Be Able To Do

- define important terminology
- distinguish between different types of fertilisers
- convert between fertiliser grade and actual levels
- discuss issues relating to fertiliser use