Text and image: Pieternel van Velden

Calcium essential for healthy plants and soil

Lime does much more for the soil than just regulate acidity

Improving the pH of soil with lime is something we're all familiar with. But what is a lot less well-known is that the calcium it contains does so much more. Apart from being an important nutrient for the plant, it also improves the structure of the soil and enriches the soil life. There are many different sources of lime, each with its own specific characteristics: it's the application that determines which type to use.

Lime is one of those products that has a story behind it. At organic fertiliser suppliers DCM in the Netherlands, they are well aware of that. They often receive questions from growers about how to use this fertiliser and what exactly it does in the soil. What's more, there are many different types and they can be applied at different times.

Account manager Twan Wubbels explains how he and his colleagues guide growers towards making the right choice. They start by explaining the origin of the material, because you soon realise that its story is quite a logical one. "You see, you can do a lot more with lime than simply boost pH," Wubbels explains.

Twan Wubbels: "Growers should separate calcium fertilisation from pH regulation."

Multiple layers

Limestone was laid down millions of years ago as a sediment of accumulated skeletal fragments of calcareous marine organisms and from precipitation resulting from high salt concentrations in seawater. Limestone is found and mined in many places across the globe. "We source our raw materials from mines in northern Germany," Wubbels says.

The calcium carbonate ($CaCO_3$), that lime is made of is found in various forms at these sites. The top layer consists of young, porous coccolithic chalk (calcite or calcitic lime). This type breaks down easily and dissolves in the moisture in the soil. When you let it run through your hands it leaves a residue, just like blackboard chalk.

The deeper layers consist of much older dolomite lime. The pressure from the top layers triggered the process of dolomitisation and converted the calcite to dolomite, making the lime much harder and less porous. This form also contains higher levels of magnesium.

The deepest layers contain lime that is unsuitable for agricultural use. Processes such as cementation and recrystallisation under increasing pressure led to the formation of marble. The deeper the mine, the older and harder the product is and the higher the magnesium content will be. The more magnesium the product contains, the less reactive it is.

Important nutrient

Calcium is an important nutrient for the plant. The mineral strengthens the cell wall and cell membranes. It plays an important role in plant resilience and suppresses diseases. It also improves the keeping qualities of products.

All plants therefore need plenty of calcium – some slightly more than others. In soils in which the pH is already high, such as in certain clay soils, growers tend to steer clear of using a lime-based product for fear of raising the pH even further. Wubbels: "This fear is often unfounded." Calcium carbonate is a source of calcium that becomes available to the plant much more gradually than, say, gypsum (calcium sulphate).

Doses of up to 600 kg per hectare of calcitic lime won't change the pH but provide a substantial amount of calcium. "You can only increase the pH by dosing more than 800 kg per hectare, but that's often too much when you're only looking to give the plants more calcium."

Correcting acidity

Besides supplying nutrients, raising the pH is the most common use of lime fertilisers in the soil. An optimal pH maximises nutrient uptake by the plant's roots. Soil organisms also perform best at a pH of between 5.5 and 6.5. If the pH rises, the amount of trace elements taken up by the roots can start to fall. If the pH drops, problems will arise with uptake of elements such as phosphate.

The soil becomes acidic as a result of the natural process of leaching. Other fertilisers can also acidify the soil. In addition, roots excrete small amounts of acid themselves. That's why it's important to regularly add lime to the soil.

The more porous the fertiliser, the faster it dissolves. When used as a pH booster, calcitic lime is best for making rapid corrections, whereas dolomite lime is used for raising the pH gradually. There are also combination products available that contain both calcitic and dolomite lime.

Not too much at once

Wubbels: "We advise growers to give a light maintenance dose once a year to supply calcium and for pH maintenance instead of a single large dose. Giving too much at once can burn the soil organisms and upsets the clay-humus complex. So you can spoil the structure of the soil, despite the fact that lime is a structure improver because of the large calcium molecules it contains, which form structural bridges between the clay particles."

Young calcitic lime is very porous. When you let it run through your hands it leaves a residue, just like blackboard chalk.

Which fertiliser is best to use depends on the type of soil and the local situation. Calcitic lime is suitable as a fertiliser even in small quantities and can quickly increase the pH in one year in higher doses. Dolomite lime starts off more slowly, but it will go on being effective for several years after application. Which one you go for – or even a combination of the two – also depends on whether you want to add magnesium to the soil.

On the left the white calcitic lime, and on the right the harder dolomite lime, which contains more magnesium.

Clay-humus complex

Adding lime to the soil has a major impact on the clay-humus complex. The positively charged calcium (2^+) will bind to negatively charged clay and humus particles and displaces the positive hydrogen ions (H^+). The carbonate (CO_3) in the $CaCo_3$ compound binds to hydrogen to form H_2CO_3, which eventually breaks down into water (H_2O) and carbon dioxide (CO_2).

The higher the cation exchange capacity of the clay-humus complex, the more nutrients are buffered and supplied. What's more, the large calcium ions improve the structure of the soil, ensuring it contains enough oxygen and enabling roots to grow more easily.

Difference lime and gypsum

When the pH is above 6, gypsum ($CaSO_4$) tends to be the calcium fertiliser of choice for most growers. Using gypsum means they can avoid raising the pH even further while still providing plant-available calcium. "You can use gypsum if you need a quick calcium shot, but it does have downsides," says Wubbels: it contains sulphate (SO_4) which is very susceptible to leaching and can cause sulphuric acid to build up in the soil. In addition, gypsum contains various ballast salts which can impact negatively on plant growth. A young, carbonate-based calcium source (calcitic lime) doesn't have these disadvantages and is released more slowly over a constant period of time. With a light dose of this kind, just as much calcium can be added without changing the pH.

"We like to see growers separate their calcium fertilisation and pH regulation. That's easy to do if you choose a suitable lime fertiliser," Wubbels concludes.

Summary

Lime fertilisers don't always get the attention they deserve, even though lime does so much more than just raise the pH. Its dual roles of pH regulation and calcium fertilisation don't make it easy to use. There are several products on the market, each with their own specific characteristics, enabling growers to keep pH correction and fertilisation separate.