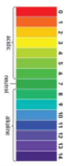
Quality of growing media

matters

More information?
RHP
+31 174 - 62 03 60
info@rhp.nl

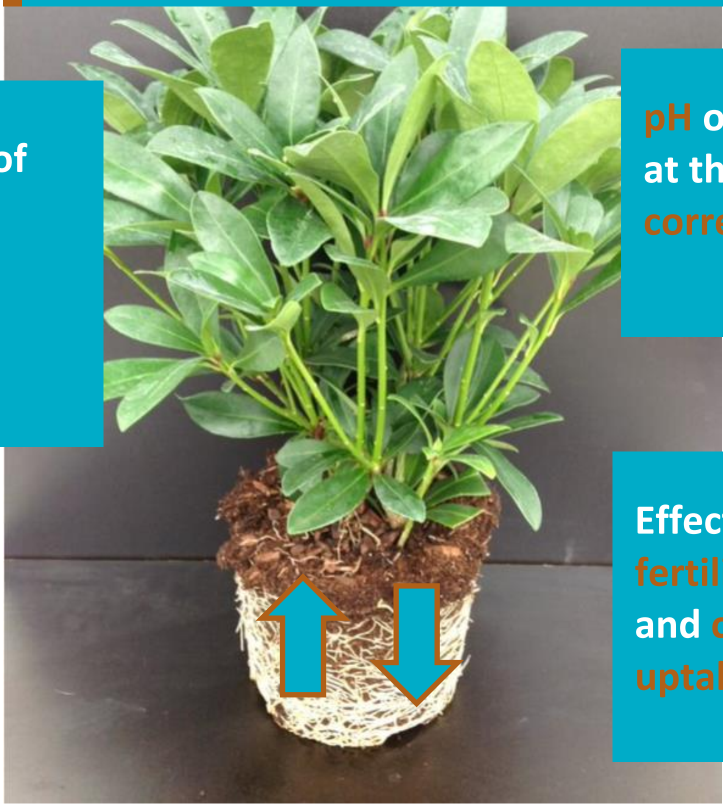
pH in growing media



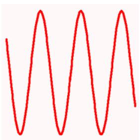
1 pH has a logarithmic scale

2 pH buffer of substrate plays an important role

3 pH of substrate at the start by correct liming

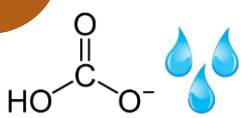


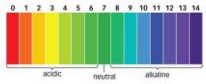
4 Effect of fertilization and crop uptake on pH



5 Change in pH due to change in EC

6 pH rises due to bicarbonate in irrigation water





1. pH has a logarithmic scale

pH is a measure of the acidity of an aqueous solution, such as a liquid or a slurry of water and soil. pH has a logarithmic scale and is expressed with a pH value from 0 to 14, with 7 being neutral. A pH below 7 is more acidic, a pH above 7 is less acidic (basic).

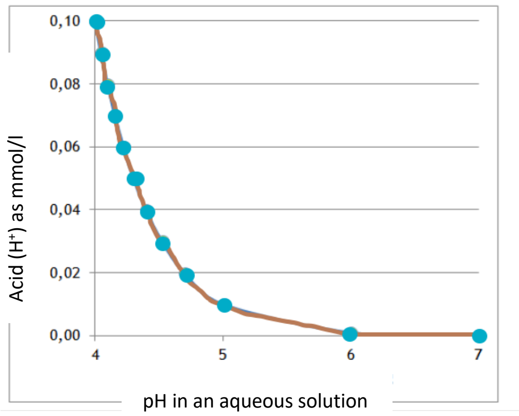
The more hydrogen ions (H^+) are present in the solution, the lower the pH. The pH is equal to the opposite of the logarithm (base 10) of the concentration H^+. The formula is as follows:
$pH = -\log [H^+]$

The table (*below*) shows the concentrations of the acid (H^+) and the "opposite pole" of acid, hydroxide (OH^-) at a pH of 0 to 14. Both are expressed in mol/l and have a certain ratio at each pH. At the neutral pH of 7, there is as much acid as the hydroxide.

pH ($\log_{10}$)	H^+ (mol/l)		OH^- (mol/l)		
0	1	10^0	0,00000000000001	10^{-14}	
1	0,1	10^{-1}	0,0000000000001	10^{-13}	
2	0,01	10^{-2}	0,000000000001	10^{-12}	
3	0,001	10^{-3}	0,00000000001	10^{-11}	zuur
4	0,0001	10^{-4}	0,0000000001	10^{-10}	
5	0,00001	10^{-5}	0,000000001	10^{-9}	
6	0,000001	10^{-6}	0,00000001	10^{-8}	
7	0,0000001	10^{-7}	0,0000001	10^{-7}	← pH neutraal
8	0,00000001	10^{-8}	0,000001	10^{-6}	
9	0,000000001	10^{-9}	0,00001	10^{-5}	
10	0,0000000001	10^{-10}	0,0001	10^{-4}	
11	0,00000000001	10^{-11}	0,001	10^{-3}	basisch
12	0,000000000001	10^{-12}	0,01	10^{-2}	
13	0,0000000000001	10^{-13}	0,1	10^{-1}	
14	0,00000000000001	10^{-14}	1	10^0	

pH and concentration acid (H^+) and hydroxide (OH^-).

For growing media in horticulture, a pH-H_2O between 4 and 6.5 is especially interesting. Most plants are grown within this range. Because pH has a logarithmic scale, adjustment is only possible to a limited extent with a strongly deviating pH. For example, the step from pH 5 to 5.5 is easier to take than from pH 4 to 4.5.



Concentration acid (H^+) in mmol/l against pH.

2. pH buffer of substrate plays an important role

Raw materials for substrates each have a certain degree to which they can absorb changes in the pH: the pH buffer. Even for the same raw material, the pH buffer can differ from one another due to its origin. In measurements, the pH buffer is expressed as **meq H^+ per point pH** (= mmol / pH point).

Large pH buffer

In general, the different peat types have a large buffer capacity. The pH buffer of peat (formed by organic acids) inhibits a pH change by releasing or binding H^+ (acid). The pH behaviour of peat substrates is more predictable due to, among other things, the large buffer. Thus, effects on the pH are reduced in a peaty substrate.

Smaller or almost no pH buffer

Other organic raw materials (such as coir fibre, wood fibre and bark) generally buffer the pH less well. As a result, the pH can rise or fall more strongly. The pH behaviour of these raw materials is harder to predict. Mineral substrates of volcanic origin (mineral wool, perlite, pumice, lava) have almost no pH buffer.

pH buffer of different raw materials in the pH range 4 - 6.5. These are indicative values from RHP research.

Raw material	pH buffer (meq/litre material)
Milled peat Baltic	23
Milled peat Irish	19
Irish fraction	17
Fine Baltic	21
Frozen black peat German	24
Black peat Baltic	24
Coir fibre	7
Wood fibre	4
Bark fine	15
Green compost	20-60

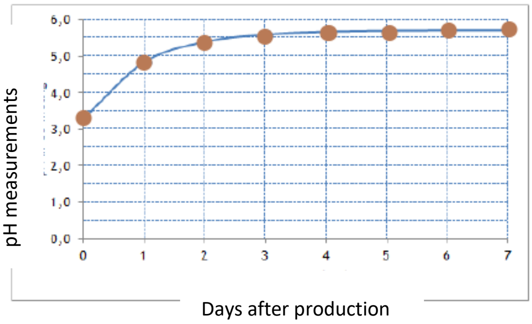
3. pH of substrate at the start by correct liming

Each crop has a preference for a certain pH. Raw materials for substrates naturally have a certain acidity. For example, peat is quite acidic and coir products and bark can be slightly acidic. To bring the pH of a substrate to the desired pH level, carbonates (CO_3^{2-}) are added which neutralize the acid (H^+). That's called liming.

Liming demand

The liming demand differs per raw material. Peat demands much more lime than other organic raw materials, such as coir products and bark. Even within the same peat type, the lime demand can vary greatly. The amount of lime needed to get a pH change, depends on the pH buffer.

Difference in lime fertilizers



Lime fertilizers for horticulture mainly contain calcium carbonate and sometimes also some magnesium carbonate (varying from 0 to 15%). Calcium carbonate dissolves rather poorly and therefore more slowly, while magnesium carbonate dissolves quite well and therefore faster. A first rapid rise in pH is therefore due to magnesium carbonate, the slower sequel is due to the slowly dissolving calcium carbonate. The particle size of the lime also plays an important role. Finer lime dissolves faster than a less fine lime. It can take up to a week after production for a substrate to reach a stable pH (see the example graph of the pH development of a potting soil based on peat).

Formation of bicarbonate

If there is still undissolved lime from a pH of 5.5 to 6, the bicarbonate content may rise. In addition to liming, the bicarbonate content can also be higher due to raw materials such as clay and compost or irrigation water with bicarbonate.

Liming too much or too little

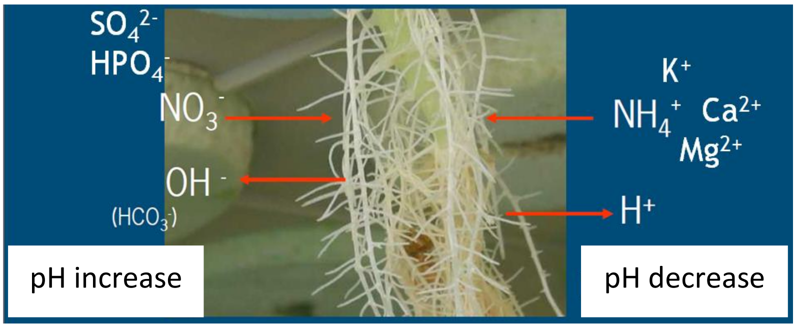
Due to a considerable amount of lime, the pH can remain high. If a plant acidifies its environment through the absorption of cations, this is immediately neutralized by carbonate. Often this is not desirable for a good absorption of trace elements. If with liming is steered to low pH's (up to 5), almost all lime dissolves immediately. This can make the substrate more sensitive to pH changes due to fertilization and plant activity. Only from a pH of 5.8 and higher, a part of the (not yet dissolved) lime amount is only left after stabilization of the pH. This then forms a *temporary* buffer against a pH decrease. So there is not always a "lime money box".

4. Effect of fertilization and crop uptake on pH

Plants have a major influence on the pH of their root environment. The pH can rise or fall due to the absorption of nutritional elements.

Crop uptake

As long as a crop absorbs as many cations as anions, it secretes as much H^+ as OH^-. The pH then remains the same. However, if a crop absorbs more cations (especially (met name K^+, Ca^{2+}, Mg^{2+} and NH_4^+) than anions, the pH will decrease due to more H^+ released by the crop. If a crop absorbs more anions (especially NO_3^-, SO_4^{2-}, HPO_4^-) than cations, the pH will rise due to more release of OH^- by the crop.



Absorption of nutritional elements by roots in relation to secretion H^+ and OH^-.

Growth stage

A crop can absorb a certain nutritional element to a greater extent at a specific growth stage. For example, during flower and fruit cultivation, crops absorb more potassium (K^+).

Fertilization during culture

Fertilization during the culture largely determines the pH. The proportion of ammonium compared to nitrate, in particular, is an important factor for the pH in the root environment.

Since plants prefer to absorb ammonium over nitrate, the ratio of these elements is a good steering mechanism. Omitting ammonium will raise the pH, adding more ammonium will decrease the pH. This influence on pH is indirectly realized by absorption by the crop. The larger the substrate's pH buffer, the smaller the effect of crop uptake on the pH. Substrates with a relatively small pH buffer are much more sensitive to this and will therefore react more strongly to influences.

5. Change in pH due to change in EC

A limited base fertilization is in a freshly delivered substrate visible as a low EC. As soon as the first fertilization is given during the culture, this EC at the start is partly decisive for the change in pH.

The pH of a growing medium in the culture can change greatly due to fertilization. As the EC increases in the root environment, more acid (H^+) is displaced from the adsorption complex and the pH decreases. This effect mainly occurs in the EC range 0-1 mS/cm.

A limited base fertilization, visible as low EC, gives a small pressure on the adsorption complex where acid (H^+) is bound. An organic substrate with limited fertilization will therefore show a pH decrease with increasing EC in the culture. This decrease in pH can be up to 0.8-1.0 point pH in cases without fertilization in a peaty substrate.

Matching base fertilization to culture fertilization

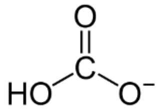
If such a decrease in pH is undesirable, the base fertilization of the supplied substrate must better match the fertilization that the grower wants to realize in the culture. Because the greater the difference in fertilization between the freshly supplied substrate and the final fertilization in the culture, the greater the pH change that occurs.
If a grower wants to start with a limited fertilization but increases it later, it is desirable to start with a higher pH. This anticipates to the pH decrease if the grower increases fertilization in a later cultivation stage.

pH changes after production

Under the influence of specific fertilization or biological processes, the pH of a substrate can also change after production (during transport or storage).

An example: part of a batch of potting soil with a slow release coated fertilizer remains with the grower for a longer period of time. The potting soil is moist, causing the fertilizer to be released. As the EC in the solution increases, acid is displaced from the adsorption complex. This causes the pH to decrease. In case the EC at the start is low, a pH decrease of more than 1 point is possible.

pH increases are also possible. For example: if a packed potting soil with organic fertilizer in it has been in transport for a long time and the fertilizer is partly mineralized. Ammonification (degradation of organically bound nitrogen to ammonium) can increase the pH by 1 point.
As a final example, fertilization with urea nitrogen. With the degradation of urea, two units of bicarbonate are formed for each unit of ammonium. This leads to a pH increase.



6. pH rises due to bicarbonate in irrigation water

The irrigation water that growers use can also have a certain influence on the pH in the culture. Spring water or surface water may contain too much bicarbonate (HCO_3^-), which increases the pH. Rainwater can be a better alternative to use.

It is also good to know that a pH rise caused by crop uptake can also lead to an increase in the level of bicarbonate. At pH values rising from about 5.7, bicarbonate will increase very obviously.

Bicarbonate content

Irrigation water with a bicarbonate content of up to 1 mmol/l has little to no effect on pH during the culture. At values from 1 mmol/l there may be (some) effect on the pH. This can be compensated for by using fertilizers containing ammonium.

In a substrate with a large pH buffer, the effect of bicarbonates in the irrigation water is better absorbed. In a substrate with a lower pH buffer, bicarbonate has a greater effect and leads to an obvious increase in pH.

Outdoor cultures and precipitation

The extent to which water with an increased bicarbonate level is used, is also important. This mainly plays a role in outdoor cultures. If there is a period with little or no precipitation, spring water or surface water will be used. As a result, there is structurally more addition of bicarbonate compared to a period with regular precipitation. In this case, the pH will increase. So even the weather can have an impact in such a case. And in that respect, every year can be different.