

Changes in substrate pH value during cultivation

The substrate pH value has a major impact on the availability of nutrients, especially micronutrients. If the pH value is too low, plants may be affected by molybdenum deficiency and manganese, zinc or copper excess. On the other hand, an excessively high pH value also leads to a reduction in the availability of micronutrients and corresponding signs of deficiency (e.g. iron deficiency).

A pH exceeding the value of 7.0 can result in nitrogen loss due to ammonia gas emissions from high ammonia nitrogen fertilizers.

Substrate manufacturers adjust substrate pH values by adding exactly defined amounts of lime. Normally, micro-finely ground calcium carbonate (CaCO_3) is the type of lime used. Micro-finely ground limes have the benefit that the desired pH value is reached within a short period of time.

Producers check pH values already during and again some time after substrate production. The pH value is measured in a CaCl_2 suspension. The values are compared to the target pH value and documented. It should be remembered that any analytic method of measurements used involves a certain level of inaccuracy. According to VDLUFA, the inaccuracy of these pH measurements is 0.2 units.

The German Fertilizer Ordinance provides for a tolerance range of 0.4 units for pH values and the RAL Quality Assurance for 'Growing Media' tolerates ± 0.4 units for pH values ≥ 5.0 and ± 0.3 units for pH values < 5.0 .

Causes for changes in pH

Even if the substrate has the desired pH value when it is delivered, the pH may change during cultivation. More specifically, both fertilizers and irrigation water used have a crucial effect on the pH value. Growers need to find out about these effects before starting to grow their crops. They are also advised to rely on an up-to-date analysis of the irrigation water.

Impact of the nitrogen fertilizer chosen on the pH value

High-ammonium fertilizer applications have an acidifying effect, i.e. they lower the pH. The process occurs both during direct take-up by the plant and, in the substrate, during the microbial conversion of ammonium to nitrate which is then taken up by the plants.

High-nitrogen fertilizer applications increase the pH value, but not to the same degree ammonium lowers the pH value. By choosing a nitrogen fertilizer with a specific ammonium-nitrate ratio, you can directly influence the pH value.

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Irrigation water – carbonate hardness is key

The level of carbonate hardness is the key factor defining water quality. Depending on the kind of irrigation water that is available in your operation, you can expect the pH value to either rise or decline during cultivation.

Very soft, low-carbonate water (e.g. rainwater) with a carbonate hardness level lower than 6° dKH draws on the calcium contained in the substrate to neutralise the acid contained in the irrigation water. As a result, the pH value will fall during cultivation.

If you apply hard, high-carbonate water having a carbonate hardness level exceeding 10° dKH to water the plants, you are adding calcium to the substrate. As a result, the pH value will rise during cultivation.

Impact of the plants on the pH value

The plants themselves also have an impact on the pH value in the substrate as they take up nutrients at the root zone level. For each positively charged ion, such as NH_4^+ , K^+ , or Ca^{++} , the plant releases positively charged H^+ ions. For each negatively charged ion, such as NO_3^- , H_2PO_4^- or SO_4^- , the plant releases negatively charged ions (OH^- or HCO_3^-). Depending on which nutrients the plants takes up, the concentration of H^+ ions in the substrate may change, thus causing a change in pH.

The different stages of crop development may also produce fluctuations in pH value. For example, flowering pot plants or fruit-bearing crops have higher potassium requirements, which causes a decrease in pH during cultivation.

Substrate pH buffering capacity

Growing media can be made from a huge variety of constituents. The constituents also have a bearing on the pH value during cultivation, because their pH buffering capacities differ greatly. For instance, composts and bark humus have a very good buffering capacity. For this reason, substrates containing an appropriate proportion of these constituents ensure that pH values remain stable during cultivation.

Recommendation: take pH measurements regularly

In addition to the fact that the above factors can all influence the pH value, it is hard to estimate how fast the fertilizer chosen and the carbonate hardness of the irrigation water will have an impact on the crop. In the summer, when water and nitrogen requirements are high and plant growth is strong, the effect on the pH value is much bigger than in the winter when growing conditions are less favourable.

The activity of micro-organisms can also influence the pH value, e.g. as they decompose organic matter.

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All these factors make it difficult to predict the pH value during cultivation. This is why regular, at least monthly, controls are recommended. To this end, take samples from several pots and the entire substrate height, because chemical properties can vary substantially in the pot depending on the irrigation system applied. Either send the substrate sample to LUFA or analyse it with our own measuring device. When using your own device, make sure to calibrate it regularly and send one calibration sample to a professional laboratory for comparison. The pH can be measured both in a CaCl_2 suspension and in water. However, keep in mind that the values measured will differ between these suspensions.

Determining the pH value directly in the pot by means of a probe is not recommended, because the results are not easily replicable and can also not be compared with general recommendations.

What to do in cases of major changes in pH values

If measurements show that changes in pH value during cultivation are substantial, it is recommended that you contact your consultant to discuss what steps you should take.

Decline in pH value during cultivation:

- If declining pH values occur regularly, you could add some coarse lime to the substrate and mix it in. Coarse lime is a calcium carbonate with particle sizes of up to 1 mm and it is slowly acting due to its small surface. This means that it can effectively be used to control declines in pH value even in very acidifying conditions.
- If the irrigation water is too soft, there is little you can do. Make sure to adjust the nitrogen fertilizer to the irrigation water.
- If the pH value is too low, you can treat the crop with a lime milk (suspension of quicklime or hydrated lime) application. However, this method is labour-intensive and experience in dosing is needed.

Increase in pH value during cultivation:

- If pH values increase because the carbonate hardness of the irrigation water is excessively high, you can use rainwater to dilute the irrigation water. Another option is to apply technical water conditioning solutions, such as ion exchangers or reverse osmosis. Adding mineral acids (nitric, phosphorus or sulphuric acid) to the irrigation water can also be an alternative. However, it should only be applied by trained members of staff.
- If the pH value is too high, it can be lowered quickly by adding elementary sulphur (sulphur flowers or wettable sulphur). Again, the drawback is that this method is very labour-intensive and determining the dosage is tricky.