Info sheet preparing nutrient solutions

Fertilizers

Fertilizers are available in solid as well as liquid form. Solid fertilizers are harder to dissolve into the solution and generally don't get taken up by the plant as easily as liquid fertilizers. Solid fertilizers also frequently contain insoluble parts or other elements which are not indicated on the product labels (Walvaart, 2021), (Kooij, 2018 (2)). Solid fertilizers are on the other hand cheaper and internationally more accessible compared to most liquid fertilizers.

Fertilizers can be subdivided into singular and compound form. Singular fertilizers are always made up out of a cationic and anionic element. The main elements within the singular fertilizers are nitrogen (N), phosphor (P) or potassium (K) which are again bound to for example magnesium (Mg), calcium (Ca) or sulphur (S). Singular fertilizers are mainly used to steer the fertilisation on the specific needs of the plant and the growth phases (Royal Brinkman, (n.d.)). A fertilizer strategy adjusted to a specific crop and all factors influencing it will result in a vital and resilient crop. Singular fertilizers can be available in both solid and liquid form. On average the price of singular fertilizers is cheaper compared to compound fertilizers, also more money can be saved by specifically targeting the needs of the crop creating optimal plant development and less waste of fertilizers. Although the use of singular fertilizers is overall more labour intensive (Van Iperen, 2021).

Compound fertilizers are made up out of a combination of N, P and/or K combined in a solid granule. These fertilizers also usually consist of other elements like for example magnesium or sulphur and some trace elements like iron, boron or zinc. Compound fertilizers are generally used out of convenience to save labour and time.

Another option are the so called 'bigbags'. There are two main bigbag systems on the market at the moment, the multifeed system from Haifa Chemicals and the Quadruplex system from YARA. The multifeed system consists of a ready-to-use formula which is custom produced based on substrate and slab water from the grower. The grower can choose to use bigbags for both the A and the B tank, or for just one bigbag for the B tank while using liquid calcium nitrate for the A tank. The second option is applied in situations where growers make use of a recipe without or low levels of ammonium. The multifeed system is easy to use and saves labour but also compromises on flexibility, besides that it is also 5% more expensive compared to the use of small bags of fertilizers. The quadruplex system consists of several bigbags, one with a combination of potassium- and calcium nitrate, one with magnesium sulphate and one with potassium phosphate. The other fertilizers can be added separately as small bags adjusted on the needs of the crop. The quadruplex system is more time consuming compared to the multifeed system although it still saves time and is easy to work with. The addition of the small bags of fertilizers also makes this system a bit more flexible. The price of the quadruplex system is similar to the price of small fertilizer bags. The downside to the use of bigbags is that it is harder to adjust and steer on specific crop needs (Onder Glas, 2004).

Solubility and fluidity of singular fertilizers at 20°C:

	Fertilizers	**Fluidity**	**g/100 ml**
1	Calcium nitrate	Solid & liquid	125
2	Potassium nitrate	Solid	31,6
3	Ammonium nitrate	Solid & liquid	192
4	Magnesium nitrate	Solid & liquid	69,5
5	Calcium chloride	Solid & liquid	74,5
7	Monopotassium nitrate	Solid	22,6
8	Potassium sulphate	Solid	11,1
9	Monoammonium phosphate	Solid	32,8
10	Magnesium sulphate	Solid & liquid	35,1

Preparing fertilizer tanks

The rule of thumb while preparing fertilizer tanks is to create a solution which is 100 times concentrated, this is done to ensure a stable EC and to prevent precipitation in the tank. It is possible to make use of higher concentrations although this increases the priorly mentioned risks (Broekhoven, 2019), (Van Iperen, 2021).

The water source used to prepare fertilizer tanks usually is rainwater because this has a stable pH between 6 – 7 and consists little to no bicarbonate. Fertilizer tanks can also be prepared using for example spring water, this is not ideal due to the high pH between 6,5 – 8 and consists high levels of bicarbonate (Deckers, 2015). When spring water is used as the water source it is essential to get rid of the excess bicarbonate using acid. It is advised to keep about 0,5 mmol of bicarbonate in the solution to function as a buffer in order to maintain a stable pH (Kooij, 2020). Spring water also often contains other elements like magnesium or chloride which should be calculated into the recipe as well.

Fertilizer tanks are divided up into an A and B tank because calcium based fertilizers cannot be combined with sulphate or phosphate based fertilizers, they will react and cause precipitation (Currey, 2021). Some companies also make use of a C tank which is used for acids, alkalis, bio stimulants or silicon fertilizers.

The A tank consists of calcium fertilizers and the B tank of sulphate and phosphate fertilizers. The remaining fertilizers can be added to both the A and the B tank, these can be subdivided over both tanks to maintain an equal amount of dissolved elements in both tanks. Trace elements are usually added to the B tank except iron chelates. To make sure trace elements are fully dissolved into the solution they can priorly be added to a small amount of warm water (0,5 – 1 L) and subsequently added to the tank (Berry Konsult, (n.d.)), (Kooij, 2023).

The pH in the B tank is more important compared to the pH in the A tank because the B tank contains elements which less easily dissolve, the pH in the B tank should always be under 5. In the A tank the pH should always be between 4 and 6, make sure the pH in this tank never drops below 4 because this will cause breakdown of chelates which results in precipitation. In tank A the pH can be lowered using nitric acid, in the B tank this can be done using either nitric, sulfuric or phosphoric acid. Keep in mind that the element bound to the acid also end up in the nutrient solution (Kooij, 2020), (Vermeer, 2021), (YARA, (n.d.)).

The solubility of elements is besides pH also very dependent on temperature, a higher temperature generally means a higher solubility (Broekhoven, 2019). In practice the standard temperature is set between 20 and 25°C (Lenntech, (n.d.)). Also the fluidity of the fertilizers influence the solubility, solid fertilizers dissolve less easily compared to liquid fertilizers. Hence why it is important to dose solid fertilizers gradually and to facilitate enough movement in the tanks by for example using a stirring installation (Van Iperen, 2021).

When fertilizers precipitated even though enough attention was paid to using the right concentrations, pH, temperature and movement this can be solved using polyphosphates. These phosphate bonds have an open structure which are able to bind precipitated elements to their open bonds and take these elements back into the solution. This reaction takes place with a pH below 7, only oxidised elements like precipitated iron are not able to be taken up. Another benefit of using polyphosphates is the effect they have after being taken up in the plant as well. These bonds can bind to immobile elements present in the old leaves and move them to the younger part, something the plant is not able to do itself. Polyphosphates are besides these priorly mentioned abilities also a source of phosphate which is easily taken up by the plant (Haas, 2022).

The EC in the fertilizer tanks shows the total amount of dissolved salts, which is a balance of cations and anions. When adjusting the fertilizer recipe it should be kept in mind that these ions should always be in balance. The EC is dependent on temperature, make sure the EC meter is corrected to a standard temperature. The general correction temperature of EC meters in laboratories is 25°C (Broekhoven, 2019), (Mondt, 2019).

Make sure to close the tank with a lid after preparing the nutrient recipe to prevent break down of chelates by UV radiation (Vermeer, 2021).

Roadmap for preparing the fertilizer tanks

1. Fill the tanks with 70% water
2. Add acid to get the solution to the right pH based on the nutrient recipe
3. Steer the solution
4. Add the fertilizers based on the nutrient recipe
5. Fill the tanks up to 100% with water
6. Dissolve the trace elements
7. Steer the solution
8. Check the pH

Order of singular fertilizers to the A and B tanks:

	A tank	**B tank**
1	Nitric acid	Nitric acid
2	Calcium nitrate	Sulfuric acid
3	Potassium nitrate	Phosphoric acid
4	Ammonium nitrate	Potassium hydroxide
5	Magnesium nitrate	Monopotassium phosphate
6	Calcium chloride	Potassium sulphate
7	Iron chelates	Potassium nitrate
8		Monoammonium phosphate
9		Magnesium sulphate
10		Magnesium nitrate
11		trace elements

(Kooij, 2018 (1)), (Berry Konsult, (n.d.))

Essential client information before a fertilizer recipe can be calculated:

- Crop
- Which fertilizers are available (brand/ composition/ fluidity)
  Keep in mind that solid fertilizer often contain impurities of elements which are not mentioned on the packaging.
- Fertilizer tanks steered on EC or volume
- Water source and analysis
  When using for example spring or city water make sure to analyse this to know the elements present in the water.
- Drain percentage and analysis

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