ENVIRONMENT & AGRICULTURE

Gypsum and the environment

Gypsum is a natural mineral which benefits from several decades of safe use and effective results in environmental applications.

Formula's high purity, natural gypsum formulations are safe, environmentally-friendly, cost-effective solutions for soil treatment in agricultural, horticultural, and leisure applications including products which are conform to the European Standard for fertilisers.

Formula's high quality products are also used in amending treated wastewater for agricultural and landscape irrigation, and in fish farming and the maintenance of rivers, lakes and ponds.

Gypsum's role in these applications:

- **safe environmentally-friendly & cost effective solution**
- **fast acting solution which starts to act as soon as applied on soil or in water**
- **chemical inertness : compatibility / use with a wide range of ingredients & treatments**
- **neutral pH : acts as a pH buffer / neutralises acidic soils & water without increasing alkalinity**
- **high solubility in water 2g/ litre (its relative solubility is 100 times higher than of lime stone and 150 times higher than of calcium carbonate) which means it can be easily carried in water.**
- **mineralising agent / natural source of calcium and sulphur for healthy plant & fish life**
- **flocculating agent / clearing muddy turbid water / loosens compact soil/ gravel improving aeration and permeability**
- **fine particle size required for creating an open structure for mushroom composting / contributes to quick and homogeneous absorption**
- **reduces chemical imbalances which can directly impact and reduce water infiltration.**
- **facilitates ionic exchange / leaching out salt / used after sea water flooding.**

Applications (pictures / illustrations)

- Fertiliser / maintenance treatment for pastures, crop or fruit growth
- Treatment and maintenance of golf courses, lawns, leisure sites
- Ingredient for mushroom composting.
- Land reclamation solution
- Solution for salt water flooding
- Loosing heavy compact clay soils
- Treatment for regenerating turbid cloudy shallow water bodies.
- Gypsum-enriched wastewater for agricultural or landscape irrigation

1. **Soil conditioner –** Improves the structure and physical condition of soils
    - Gypsum helps improving the structure and physical condition of soils, through flocculation, by loosening tight, compacted soil, generally improving soil structure, aeration and permeability.
    - The physical condition or structure of the soil has a major impact on its workability, crop output, its capacity to absorb water (which facilitates irrigation) and to dry in a short period of time. A good soil is characterized by a high porosity, good drainage and aeration. Porosity is crucial for the normal development and optimal growth of plants and to assure good harvest productivity.
    - During cultivation, the structure of soils unavoidably tends to deteriorate. Fallow land suffers from the traffic of agricultural machines that compact the soil. Rainfall may cause erosion and stagnant water may reduce the supply of oxygen in the zone of the roots.
    - Gypsum helps stabilise soil aggregates to ensure plants have enough water to grow, but not enough to drown. Also, it provides a constant supply of oxygen to the roots of the plants, without the dangerous accumulation of carbon dioxide.

Gypsum is particularly effective on breaking up heavy clay soils, and generally reducing the risk of erosion, and flooding.

- Neutralize acidity or alkalinity levels of soils:
    - Gypsum acts as a pH buffer, which can contribute to neutralising soil acidity or alkalinity thereby assisting the assimilation of nitrogen.
    - A quite common phenomenon in dry soils is that during evaporation (after irrigation with large quantities of water) the soluble salts that were in suspension deposit on the surface. These soluble salts can be carbonates, bicarbonates, sulphates, calcium chloride, magnesium chloride, potassium chloride or sodium chloride.
    - Alkaline soils notably contain large quantities of sodium which cause the bad physical condition of soils in a way that plants are affected by nutritious deficiencies.
    - To recuperate these soils requires both chemical changes and physical improvements. The addition of gypsum involves two reactions: the ions of calcium replace the interchangeable ions of sodium and convert the sodium clay into calcium clay. The calcium sulphate reacts with the sodium carbonate and turns into calcium carbonate and sodium sulphate. At the end of the reaction, the sodium sulphate is evacuated from the concerned ground.
    - Gypsum formulations are used for leaching out salt during land reclamation, or following sea water flooding by from tidal rivers, and can also correct Magnesium / Calcium ratios in high magnesium soils
- Counterbalance high sodium content irrigation waters *(HB: also to be linked to the category "water treatment")*
    - In areas where the irrigation water contains high rates of sodium (in relation to the content of calcium), soils are generally saturated with sodium and impermeable to water and air.
    - Cultivation shows slow germination and roots development as well as low productivity.
    - Gypsum is used to counteract the sodium and to improve the characteristics of the soil such as adequate penetration and filtration of the water as well as humidity retention. It is applied via the irrigation water or can be applied together with the fertilizer.
- *Use / application (link to TEXT 1 at the end)*

2. « Fertiliser » / « Source of nutrients »

- Gypsum is used in agricultural and horticultural fertilisers, dressings and pesticides. Calcium, nitrogen, phosphates, potassium and magnesium and sulphur are indispensable elements for fertilisation, and healthy plant growth. Gypsum provides a natural source of calcium and sulphur, which can be directly assimilated by plants and are vital to fertilisation and healthy plant growth.
- Fertilisers may be needed in soil for a number of reasons, including humus deficiency, incorrect crop rotation and specific requirements of a particular crop. They may be required due to the geological origin of the soil in certain areas.
- Source of calcium
    - Calcium is an important element for plant growth. It stimulates the formation of micro organisms necessary to fix nitrogen in the roots of legumes.
    - The advantage of adding gypsum to the soil is that it does not significantly impact the alkalinity of the soil; that is why it is an excellent source of calcium for soils with a relatively high alkalinity or for cultivation requiring a specific degree of alkalinity.
    - Cultivations that may require the addition of calcium are:
        - ❖ Cotton
        - ❖ Tobacco
        - ❖ Potatoes
        - ❖ Tomatoes
        - ❖ Apples
        - ❖ Nectarines
        - ❖ Citrus fruits
        - ❖ Legumes such as soy, alfalfas and peanuts
- Source of sulphur
    - Sulphur activates the function of the chlorophyll, working together with iron and magnesium. Sulphur, together with nitrogen and potassium, are constituent

elements for base proteins and other fundamental substances of vegetable matter. Sulphur also plays an important role in the actions carried out by plant cells.
    - In areas of sulphur depleted soils, gypsum can be applied, as it is an available source of sulphur. Sulphur depletion can occur from intensive farming which exhausts the natural reserves in the soil and also from the use of complex fertilisers that are weak in sulphur.
    - Cultivations that may require the addition of sulphur are:
        - Alfalfas
        - Peas
        - Beans
        - Cabbage
        - Beets
        - Onions
        - Garlic
- *Use / application (link to TEXT 1 + 2 at the end)*

3. Composting

- Production of mushroom composting
    - One particular area of application of gypsum is in the production of compost for mushroom growing. In this case a relatively fine particle size product can be used. Mushrooms are part of the fungus family which is unable to use the sun's energy to combine water and carbon dioxide into carbohydrate. Instead they must live on plant and animal remains.
    - The main constituents of mushroom compost are wheat straw and manure.
    - The flocculating action of the calcium sulphate helps the compost to maintain an open (non compact) structure, preventing it from turning sour. It also provides a buffering effect that assists the compost in staying within a pH range of around six to eight which favours the growth of the spores.
    - Gypsum ensures that chemically combined nitrogen levels are maintained, that ammoniac odours remain limited (the ammoniac vapours can generate eye diseases) and that the compost is more nutritive. The chemical reaction is that gypsum helps transforming the instable ammonium carbonate of the compost into stable ammonium sulphate: $2NH3 + CO2 + CaSO4\ 2H2O$ —> $(NH4)2SO4 + CaCO3 + H2O$

4. Water treatment

- Regeneration of silted, muddy water bodies
    - Aquabel is a safe, natural, economic treatment to regenerate water bodies polluted by an excess of organic matter. It is a cost effective means (compared to dredging of rivers and lakes) of limiting the proliferation of algae / rooted plants) caused by excess nutrients in water.
    - It also reduces the build up of silt and sediment, which can lead to river choking and flooding, and frees silted spawning grounds, encouraging fish reproduction (salmonidae).
    - Aquabel is an effective solution for rapidly clearing muddy, turbid water, flocculating suspended mud and clay particles. It is a natural and safe calcium source for plant and fish life, and an effective pH buffer bringing water to a neutral, non toxic level. Prevents the formation of calcareous formations on river beds
    - Improves zones which have suffered damage from the intensive use of liming (acidification)
    - *Use / application (link to TEXT 3 at the end)*
- Wastewater treatment for irrigation
    - Gypsum is used to amend certain types of treated wastewater, in order to reuse this water source for agricultural and landscape irrigation.
    - Due to the varying chemical constituents which wastewater is composed of, laboratory analysis of both the soil and water will be made to ensure the wastewater is suitable for irrigation purposes, and this application is subject to local legislation and regulations due to the potential impact on human safety.
    - Wherever it is possible to recycle this water source there are significant environmental benefits, as it reduces the requirement for naturally available water and also provides water which may be quite rich in mineral sources.

- **Studies have indicated that crops irrigated via drip injected gypsum (in solution) on a daily basis showed improved crop yield with heavier fruits, in greater number.**

Use / Application

TEXT 1

Due to its chemical structure, gypsum-based formulations are compatible with other ingredients as an additive or carrier in environmental formulations, and may be safely used in conjunction with other fertilisers and treatment products.

Gypsum may be either spread on the soil in powder form or sprayed-applied in a solution.

The main application seasons are from spring through to autumn in temperate zones.

To replenish soils and correct pH levels after winter washing out
To condition soil for crop sowing and facilitate irrigation
In conjunction with other fertilisers (ex lime to counter-effect any negative consequences of over-liming

TEXT 2

Dosage levels

Plants producing low protein levels	**Plants producing high protein levels**	**Plants producing high protein levels and containing sulphur**	**Fruit trees**
Corn, wheat, maize potatoes, sugarbeet	Clover, broad beans haricot beans, peas, sunflowers, Soya	Cabbage, mustard, garlic, onions, radish, turnips, chicory, celery, rape	Apples, Pears, Plums
For regular maintenance			
60 – 80kg of SO_3 (25 –30kg of S)	100 – 130kg of SO_3 (40 –50kg of S)	200 – 230kg of SO_3 (80 – 90kg of S)	200-230kg of SO_3
Treating problem soil			
100– 130kg of SO_3 (40 –50kg of S)	130– 150kg of SO_3 (50 –60kg of S)	250 – 300kg of SO_3 (100 – 120kg of S)	140-150kg of SO_3

TEXT 3

Aquabel

- ⇨ Aquabel is dissolved in water and projected using an air gun. This method of application increases oxygenation and ensures the best possible dispersion of homogeneous particles for optimal results.
- ⇨ Water temperature should be between 10℃ - 18℃ for micro-organisms to be active and decompose organic matter.
- ⇨ 2 or 3 treatments spaced out over a season will be more effective than one application. This is particularly true for the treatment of lake bed sediment.

Food

- Formula proposes natural, high purity gypsum products for use in the food industry, in accordance with EU food additive regulations. Quality control measures, procedures and systems are in place to maintain the required food hygiene standards in this application.
- Two product categories are proposed: gypsum as a food additive and gypsum as a food processing aid.
- Gypsum as a food additive
  - **Food Additive Gypsum (E516)**
    A natural source of calcium, gypsum is used as a nutritional ingredient in foodstuffs including bread, pasta and pet food.
  - **Ground Gypsum Superfine White (Newark, UK)**
  - **Ground Gypsum FG200 (Newark, UK).**
- Gypsum as a food processing aid
  - **Food Processing Aid Gypsum,**
    Gypsum may be used during the treatment or processing of foods or their ingredients, to fulfil a certain technological purpose.
    Gypsum serves as a filtration aid to improve the juice extraction in sugar processing, to enhance fermentation and clarity in beer brewing and as a flour extender in bread formulations.
  - **Alabaster Brilliantweiss (Walkenried, Germany)**

Animal feed will be removed from our list of applications as we do not meet requirements.