Soluble Gypsum – What is it?

1. BACKGROUND

The use of gypsum[1] as a soil amendment and fertiliser has been well documented for over 200 years. Historically, gypsum has been spread over the ground using mechanical or manual methods. Depending on the situation, this relatively coarse gypsum has often been incorporated into the soil to hasten its effect. Unfortunately, in many cases gypsum particles can still be identified many years after spreading took place. The particle size directly affects the degree to which gypsum becomes available in the soil.

In reality, conventional ground spread gypsum only enters the soil solution over a prolonged period of time; hence only a small percentage is available at any given time. Similarly, in a minimum till operation the opportunity to work gypsum into the soil profile is not available – further reducing the effectiveness of the application.

Fine milled gypsum now offers a high performance alternative to conventional techniques and practices. Gypsum can now be applied in a form that ensures 100% of the gypsum is available. This form of gypsum can be applied via existing irrigation systems and/or applied as a slurry via airplane.

In the case of water run application the calcium and sulphate components of gypsum become immediately available as they are present in a soluble form. Application of gypsum can be tailored for soil and water conditions and plant growth stage.

For dryland use, fine milled gypsum can be applied as a slurry. Application from the air ensures an extremely accurate coverage with no dust. The water acts as a carrier and 'sticks' the slurried gypsum to the ground until such time as moisture incorporates it into the soil solution. Wind cannot blow the gypsum away and it becomes fully available after the first rain or irrigation.

[1] Gypsum – calcium sulphate di-hydrate ($CaSO_4.2H_2O$). Commonly known as calcium sulphate.

2. WHAT CAN SOLUBLE GYPSUM DO?

2.1. Where is Soluble Gypsum Particularly Effective?

- Sodic soils
- High sodium irrigation water
- Effluent irrigation water
- Calcium deficient soil – plant nutrient source
- Low-solute water (too pure)

2.2. What Benefits can Soluble Gypsum Have?

Soluble gypsum has many benefits, some of which are listed here:

- *Improves Soil Structure*

Gypsum provides calcium, which is needed to flocculate clay in soils. Flocculation is the process in which many individual small clay particles are bound together in fewer, but larger, particles. This allows root growth, and air and water movement.

- *Reclaims Sodic Soils*

Gypsum is the most economical way to reclaim sodic soils. The calcium replaces the sodium held on the clay-binding sites. The sodium can then be leached from the soil as sodium sulphate.

- *Stops Water Run-off & Erosion*

Gypsum improves the water infiltration rate and hydraulic conductivity of the soil. It is protection against excess water run-off that accompanies erosion.

- *Prevents Waterlogging of Soil*

Gypsum improves the ability of soil to drain and not become waterlogged due to a combination of high sodium, swelling clays and excess water. Improvement of infiltration rates and hydraulic conductivity, with the use of water-soluble gypsum, add to the ability of soils to have adequate drainage.

- *Makes it Possible to Utilise Low Quality Irrigation Water*

Gypsum is essential when low quality irrigation water must be used, both in terms of short-term crop health and sustainable soil health.

- *Improves Water Efficiency*

Gypsum increases water-use efficiency of plants. Improved infiltration rates, improved hydraulic conductivity and increased water storage in the soil all lead to deeper rooting and better water-use efficiency. From 25 – 100% more water can become available due to less run-off and increased water holding capacity.

- *Helps Plants Absorb Nutrients*

Calcium is essential to the mechanisms by which most plant nutrients are absorbed.

- *Multiplies the Value of Other Inputs*

Gypsum can improve the plants response to all other inputs, including fertilisers. It more the adds to their beneficial effects – it multiplies them.

- *Improves Low-Solute Irrigation Water*

Irrigation water from rivers that no longer have leachable salts either penetrate poorly into the soil or causes soil particles to degrade, further affecting water penetration. This can be treated with soluble gypsum.

- *Improves Swelling Clays*

Gypsum can decrease the swelling and cracking associated with high levels of exchangeable sodium on the montmorillonite type clays. As sodium is replaced by calcium on the clays, they swell less and therefore do not easily clog the pore space through which air, water, and roots move.

- *Binds Organic Matter to Clay*

Gypsum is a source of calcium, which is a major mechanism that binds organic matter to clay in soil. This gives stability to soil aggregates. The value of organic matter is increased when it is applied with soluble gypsum.

- *Makes Magnesium Non-Toxic*

In soils having unfavorable calcium : magnesium ratios, soluble gypsum can be utilised to achieve a more desirable ratio.

3. SOLUBLE GYPSUM Q & A

3.1. How Does Sodium Manifest in the Soil?

Sodium ions (Na^+) adhere to the soil colloid (or soil mycelle / ion exchange site). The sodium effectively weakens the bonds between soil particles. When these particles are wetted they become detached and swell. The detached clay particles then disperse throughout the soil water, making it cloudy. The dispersive clay particles clog the soil pores – affecting water infiltration and drainage.

3.2. Where Does the Sodium Come From?

The sodium enters the soil solution in a soluble form via the irrigation water. Nearly all water sources carry varying amounts of sodium, calcium, magnesium, chloride, & bicarbonate - at least these are the elements we are most concerned with.

3.3. Surely There Isn't That Much Sodium in my Water?

The amount of sodium in a water supply may not always seem like a lot. It is sometimes best to quantify that amount in terms of a physical amount rather then a percentile reading.

Every Part Per Million (ppm) is equivalent to a Kilogram Per Megalitre (kg/ML). Therefore for every megalitre of water applied, where the water has a 100ppm sodium content, 100kg of sodium is being applied also.

3.4. Why Won't the Gypsum Fall out in the Irrigation System?

Gypsum is only 0.24% soluble – a very small amount, but still sufficiently soluble to treat almost any high sodium water problem. 0.24% solubility translates to a little over 20 Meq. Treatment rates of up to 12 Meq are physically possible with a variety of different water sources. Excessive amounts of bicarbonate in the water can affect the solubility of gypsum – though this scenario is rare.

Fine milled gypsum can be held in *suspension* using a suitable fertigation unit. The key to ensuring that gypsum will go into solution is the particle size of the fine milled gypsum. By decreasing the size of the gypsum particles we exponentially increase the surface area : mass ratio (surface area increase whilst mass remains constant). When the particle size of the gypsum is small enough we can theoretically 'wet' each and every particle of gypsum.

When the fine milled gypsum is injected, as a suspension, into an irrigation system main line it will go into *solution*. With the ultra-fine particle size, and within the constraints outlined above, the gypsum will dissolve in the irrigation

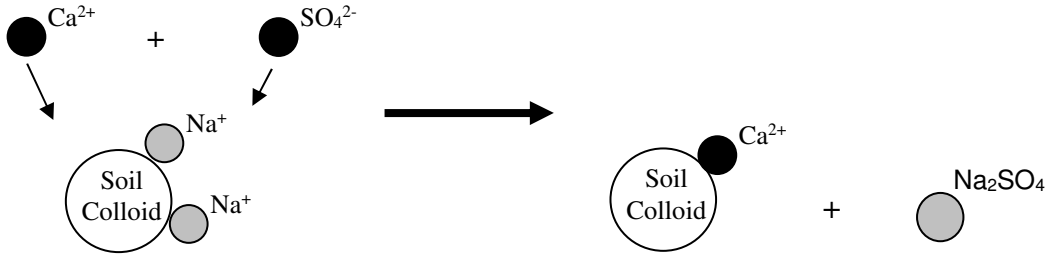
water like sugar does in a cup of tea. At this point the gypsum will travel wherever the water does. When gypsum is in the Soil Solution it exists as free Calcium ions (Ca^{2+}) and free Sulphate ions (SO_4^{2-}).

$$CaSO_4 + H_2O \rightarrow Ca^{2+} + SO_4^{2-} + H_2O$$
Gypsum + Water Calcium + Sulphate + Water

3.5. What Happens in the Soil When the Soluble Gypsum Arrives?

The Na^+ (sodium) ions are forced from the soil colloid by the Ca^{2+} (calcium) ions. They then become attached to the free SO_4^{2-} (sulphate) ions and form Na_2SO_4 (Sodium Sulphate). Na_2SO_4 is a satisfied bond and is also leachable – hence it can be carried away through the soil profile by the percolation (irrigation) water.

$$Na^+ [\text{Soil Colloid}]\ Na^+ + Ca^{2+} + SO_4^{2-} \rightarrow Ca^{2+} [\text{Soil Colloid}] + Na_2SO_4$$



3.6. At What Soil Depths is Soluble Gypsum Effective?

When in a soluble form, gypsum will displace sodium at soil depths in excess of 2 metres. Application rates and the overall treatment plan must be determined by interpreting water and soil analyses. Balancing the positively and negatively charged salts present in the soil and water is the key to a healthy and friable soil.