From Waste to Asset: Use of Yellow Gypsum as a Source of Sulphur in Agriculture

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Ever enjoyed burgers with mustard sauce? Or pizza dishes with garlic bread? Oh indeed! It's an obvious answer given the billion dollar fast-food business worldwide. And what about the different varieties of lip-smacking biriyani, kofta korma, kebabs and other splendid non-veg dishes spread across India? It`s almost impossible to imagine any *Puja*, without *Pet-Puja*. Even for vegetarians, and all food lovers everywhere, the ingredient that brings that *Su-baas* in Baasmati and *tadka* in *daals*, the thing that makes most spices so spicy and oils to smell so nice, is also present as a basic ingredient of Cysteine (26%), Cystine (27%) and Methionine (21%), three beads in the necklace of 23 Amino acids in the Pandora`s box of life. Scientists call that Gem Sulphur!

Yes! This is the 13th most abundant element in the Earth`s crust with an average concentration of 0.06% and yet it has been recognized as the fourth major essential plant nutrient. Not only that, being an integral component of most of the proteins, enzyme (Nitrogenase) and co-enzymes (co-enzyme-A) vitamins (Biotine, Thiamine or vitamin B_1) and hormones, it is associated with most of the life sustaining physiological activities in both plants (Photosynthesis, Biological N-fixation, etc.) and animals.

Sulphur can be abundantly found in crops of onion and oilseed groups (specially in groundnut) in the form of volatile compounds and is responsible for the aroma and taste of different varieties of aromatic rice and upliftment of protein quality in pulses.

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But the sad part is, despite being so important for our health and hygiene; it is ignored in Indian agriculture. Almost 40% of our agricultural land is severely deficient in sulphur, and due to constant negligence, this statistic is rising year after year. On the sidelines, this is also inviting a devil to grasp our lush pastures and fertile land in the North-Western part of India. Yes, you guessed it right! It is Desertification! How? It is now a well -known fact that a vast portion of agricultural land in western UP, Haryana and Punjab is under threat of soil sodicity, a formidable problem of saturation of nearly all soil exchange sites with Sodium (Na^+) ions, that breaks down soil structure (de-floculation), restricts soil aeration, impedes drainage (surface compaction) and eventually leads to lose its fertility status. If this problem persists, we are afraid that we may lose this part of the great Gangetic plain under the sand dunes of mighty Thar desert forever!

We are talking about it because potentially the answer lies within sulphur. Calcium sulphate di-hydrate ($CaSO_4.2H_2O$) is well known to curb sodicity problem among affected soils. So, there is no wonder when we`re picking this up for the solution. But, here`s a twist, and guess what, we`re making our approach environment friendly also. Here`s how…

Steel slag is produced during the Linz Donawitz process or the LD process in an integral steel plant @ 125kg/ton of Steel. This steel slag, also known as LD slag is highly basic in nature, as it is rich in calcium bearing mineral phases like mono, di and tri-calcium silicates along with free lime and some metallic iron. Apart from being used for road construction, steel slag can also be used as a sinter ore fluxing agent. However, at the same time these applications can`t take care of the huge stockpile of this slag at the enormous rate at which it is produced. With the rapid development of steel industry, the global crude steel production reached a stage of 1.623 billion tons in 2015. So, disposal of this huge amount of bi-product generated in the process requires substantial monetary involvement in one hand while loss of valuable resources on the other.

Therefore, value addition of steel slag needs to be explored so as to produce materials having diverse applications. In this context, yellow gypsum (of purity of almost 86%) is being synthesized by atmospheric leaching of LD slag with dilute Sulphuric acid at 100°C.

This yellow gypsum contains quite a good amount of essential plant nutrients like calcium, sulphur in huge proportion, while phosphorus, iron, silicon, manganese, magnesium and aluminum in moderate quantity, with a very minute amount of heavy metal (titanium and chromium) as impurity.

As chromium is needed @15-35 mcg/day to regulated sugar metabolism and fight diabetes in the human body, the chromium content in yellow gypsum, instead of posing problem of Cr toxicity, can be an added advantage, if this element can be accumulated in plants grown with it. This led us to explore the possibility of this product, not only as a weapon to fight sodicity, but also as a source of sulphur in different component crops under a vivid range of cropping system.

Therefore, with the objectives to testify the properties of Yellow Gypsum in different properties of soils under experiment, along with exploring its potentiality as an indigenous source of S, Ca, Mg, P, Fe and Si, keeping the risk of heavy metal loading of the soil in mind. Also, effects of organic manures, conventional chemical fertilizers, bio-fertilisers and management options are under observation.

So, we`ve aimed to design our experiment in four types of soils, that have been collected from sodic belt of western U.P. (Sandila, Lucknow), acidic lateritic soil from Bankura, W.B., saline soil from Sundarbans area of W.B. and alluvial soil from Jaguli, Nadia, W.B. and taken under green house facility of Bidhan Chandra Krishi Viswavidyalaya for pot culture experiment in 216 pots (each having 6kg of respective soils, 6 doses of Yellow Gypsum and 3 doses of Farm Yard Manure as organic manure, all with 3 replications), to be tested under rice-mustard-ground nut and rice-wheat-spinach cropping system.

From a potent environmental pollutant to an asset, we`ve therefore metaphorically planned to raise a phoenix out of ashes, so that one day we can have a beautiful future, with fertile lands and great food with embedded medications to counteract diabetes in the diabetic capital of the world!