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Gypsum - "A Multifaceted Mineral" for High-Yielding Groundnut Cultivation

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ABSTRACT

Gypsum, when judiciously applied, proves instrumental in enhancing soil structure, mitigating salinity, and improving water infiltration in groundnut fields. The amendment's positive influence extends to nutrient availability, particularly calcium, fostering healthier and more resilient groundnut plants. This, in turn, translates to increased yields and improved nut quality. Additionally, gypsum's ameliorative effects on soil structure contribute to enhanced aeration and root development, optimizing nutrient absorption and water utilization. Overall, the application of gypsum in groundnut cultivation emerges as a promising agricultural practice promoting increased productivity.

Groundnut (*Arachis hypogaea* L.) often hailed as the "King of Oilseeds" plays a vital role in the global food system. It is also known by various names like the earthnut, peanut, and monkey nut. Unlike many other legumes, its flowers develop above the ground, but after pollination, the flower stalk elongates, burying the developing pods underground. This unique growth pattern of positively geotropic pegging makes it an unpredictable legume. Groundnut boasts a whopping 45-50% oil content, making it a valuable source of edible oil. This oil is not only delicious but also versatile, used in cooking, cosmetics, and even biofuels. Additionally, it ranks as the third most crucial source of vegetable protein, contributing 25-30% protein. Groundnut cultivation is widespread, spanning 295 lakh hectares across the globe. This vast cultivation area results in a significant yield of 487 lakh tonnes, with an average productivity of 1647 kg per hectare (FAOSTAT, 2019). India takes the lead in groundnut acreage, securing its position as the second-largest producer worldwide, contributing 101 lakh tonnes with a productivity of 1816 kg per hectare during the year 2020-21.

Accounting for a staggering 30% of India's total oilseeds production, groundnut plays a pivotal role in the nation's agricultural landscape. Gujarat leads the nation, claiming a dominant 33% share, while Uttar Pradesh contributes a valuable 0.89%. Beyond its impressive production figures, groundnut boasts a unique and valuable feature: its ability to fix atmospheric nitrogen through symbiotic bacteria. This nitrogen-fixing ability, for example, allows for reduced reliance on expensive nitrogen fertilizers, ultimately enhancing soil health and making groundnut ideal for sustainable crop rotation practices.

Beyond basic nutrients, groundnuts thrive on a wide range of minerals for healthy pod formation and rich oil content. Boron, crucial for root and nodule growth, directly impacts soil nitrogen fixation. In soils where groundnut is cultivated, particularly light-textured soils in India, boron deficiency is common. Borax is applied at the rate of 10 kg/ha as basal or foliar application of 0.3% boric acid (3g/lit) two times at 15-day intervals is done as a nutrient management strategy. Boron application has shown positive effects on quality improvement, protein synthesis, amino acid formation, and increased pod yield in groundnut crops. (Naiknaware *et al*., 2015; Ansari *et al*., 2013; Chitdeshwari and Poogothai, 2003)

The key elements, calcium and sulfur, play a significant role in augmenting the production and productivity of groundnut. Groundnut demonstrates a unique ability to absorb calcium and sulfur through peg and pod development. Sulfur is essential for the synthesis of sulfur-containing amino acids and actively participates in oil synthesis influencing the quantity and quality of oil. Sulfur contributes to the formation of cystine, an amino acid crucial for seed protein quality. Additionally, calcium nutrition is identified as a limiting factor for groundnut production. While the calcium absorbed by the roots does not move to the developing pod, the calcium necessary for pod formation is directly taken up from the soil solution. The plant's need for calcium and sulfur is met by the application of Gypsum, a multifaceted mineral.

Gypsum, a historical fertilizer used in the United States for over 250 years, stands out as one of the earliest soil amendments. Gypsum amendments have demonstrated their efficacy in improving the physical properties of certain soils, particularly heavy clay soils. The application of gypsum improves soil structure by loosening up tight compaction and promoting better water infiltration. It reduces soil crusting and thus facilitates smoother seedling emergence and easier pegging and pod development. It also contributes to the reclamation of the alkaline soil. Furthermore, gypsum applications have proven effective in reducing soil erosion and nutrient losses, as well as decreasing soluble phosphorus concentrations in surface water runoff. With its moderate solubility, Gypsum is a natural powerhouse of calcium (23.3%) and sulfur (18.6%), and serves as a crucial tool for groundnut farmers worldwide. Gypsum provides calcium for strong cell walls and sulfur for protein synthesis, therefore contributing to robust pod development. Ensuring a constant supply of calcium to plant roots is essential, as calcium movement from one plant part to another occurs slowly. The application of gypsum, a reliable calcium source, has shown positive effects on horticultural crop quality. Studies have demonstrated the statistical significance of sulfur treatments with gypsum in increasing alfalfa yields.

Chemical properties that benefit from gypsum application include the mitigation of subsoil acidity and aluminum toxicity. This improvement fosters deep rooting, enabling plants to access ample water and nutrients during drought periods. Understanding the composition and properties of gypsum is crucial for making informed recommendations for its agricultural use. Pure gypsum ($CaSO_2.2H_2O$) consists of 79% calcium sulfate ($CaSO_2$) and 21% water (H_2O), with calcium and sulfur content at 23.3% and 18.6%, respectively. Gypsum's moderate solubility in water, approximately 200 times greater than lime ($CaCO_2$), facilitates the mobility of calcium in the soil profile, making it more available to plant roots. Application of gypsum should be avoided in calciferous soils. Gypsum is applied at the rate of 400 kg/ha at 40-45 days after sowing. Gypsum at the rate of 50 percent as basal application reduces *kalahasti malady*, a nematode infestation in groundnut.

CONCLUSION

In light of these advantages, the judicious application of gypsum in groundnut cultivation stands as a promising agricultural practice, offering a holistic solution to address various soil-related challenges such as soil nutrient composition and soil structure. Thus, gypsum is a valuable investment for thriving groundnut crops and bountiful harvests.