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Gypsum-an inexpensive, effective sulphur source with multitude impact on oilseed production and soil quality- A review

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ABSTRACT

Mustard and soybean are the most important edible oilseed crop of India. Oilseed crops like mustard and soybean in general have high sulphur requirement owing to higher seed and oil yield. Reports of sulphur (S) deficiency and consequent crop response, particularly in oilseed crops, are quite ostensible. Insufficient S can affect the yield and oil quality of oilseed crops. To overcome deficiency of S, gypsum is the cheapest and widely available source for correcting S deficiency and improving physico-chemical properties of the soil. Gypsum is a moderately soluble source of the essential plant nutrients, calcium and sulphur, and can improve overall plant growth. Gypsum also improves the physical and chemical properties of soils and reduces erosion losses of soils and nutrient concentrations (especially phosphorus) in surface water runoff. Gypsum in many studies are known to improve crop yield, which might be the result of synergistic effect of various parameters like crop, soil, climate and other parameters specific to a region. In oilseed crops, gypsum application is mostly confined to meet S requirements, but its effect on soil physical and chemical changes need to be evaluated for sustainable crop production.

Key words: Crop yield, Gypsum, Mustard, Soil properties Soybean, Sulphur.

Sulphur is an essential nutrient for oilseed production. It is the 13th most abundant element in the earth crust with an average concentration of 0.06%. Sulphur (S) is increasingly being recognized as the fourth major plant nutrient after nitrogen, phosphorous and potassium (Jamal *et al*., 2010). The sulphur requirement of oilseeds and pulses is fairly high in comparison to the other cereals and millets. There is a drastic change in the production and nutritive value of crop produce due to absence of S. The amount of S required to produce one ton of seed is about 3-4 kg S for cereals (range 1-6); 8 kg S for legume crops (range 5-13); and 12 kg S for oilseed crops (range 5-20). In general, oilseed crops require about the same amount of S as, or more than, phosphorus for high yield and product quality (Jamal *et al.* 2010). Oilseeds from one hectare remove sulphur nearly between 10 and 25 kg and that of pulses 5-10 kg annually which depends upon the crop, soil and environmental factors (Singh and Singh, 2016). It has been reported that in India more than 41% of soil are deficient in S (Singh, 2001). Sulphur is best known for its role in the formation of amino acids methionine (21% S) and cysteine (27% S); synthesis of proteins and chlorophyll; oil content of the seeds and nutritive quality of forages (Patel *et al.* 2013). Among the various S sources, gypsum is the cheapest source of S which is known to significantly improve crop biometric parameters, pod and halum yield (Mandal *et al.*, 2005) and also used as amendment for salt affected soils (Rathod *et al.*, 2005). Oilseed crops, particularly, mustard and soybean have high S requirement. Among many agronomic factors responsible for low yield is imbalanced and injudicious use of fertilizers also limits the crop production.

Mustard is the third most important oilseed crops after soybean and groundnut in India occupying 6.65 million-hectare acreage, 7.88 million tonnes production and 1,185 kg ha^{-1} productivity (Raju *et al.* 2014). India is one of the largest rapeseed-mustard growing country in the world and occupying the first position in area and third position in production after China and Canada (Singh *et al.* 2017). Major states producing mustard are Rajasthan, Punjab, Haryana, Uttar Pradesh, Bihar, Madhya Pradesh, West Bengal and Gujarat. Rajasthan ranks first in both area and total production of mustard. Among the different states, Uttar Pradesh alone produces about 20 percent of total rapeseed and mustard production in India. The contribution of rapeseed-mustard to the total oilseed production in India is 26 %, and the production of 16.4-20.5mt rapeseed-mustard would be required. This target could be achieved through area expansion and/or increase in productivity of rapeseed-mustard. In world, India account 19.29 % of the total acreage and 10.07 % of production of rapeseed and mustard (FAO Statistics, 2015).

Soybean, unlike other legumes, is both a pulse and oil seed crop. Soybean known as “miracle bean” or “golden bean” has established its potential as an industrially vital and viable oilseed crop in many areas of India. It is a cheapest

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source of vegetable oil and protein. The productivity of soybean is less in India as compared to world average (2484.1 kg ha^{-1}). The major soybean producing states in India are Madhya Pradesh, Maharashtra, Rajasthan, Andhra Pradesh and Karnataka. The imbalanced and inadequate nutrition is found to be one of the major limiting factors for its poor yield. Among the major nutrients, sulphur is found to be quite important now a day in many soybean-growing areas. The yield attributing characters of crops are greatly affected by sulphur application.

To overcome the S deficiency in soils and crops a number of S containing fertilizers as well as other S containing by-products from industrial processes are available and used by the farmers. Most commonly used S fertilizers like potassium sulphate, gypsum, phosphogypsum, elemental sulphur, pyrites and ammonium sulphate etc, are found to be quite useful in augmenting the mustard and soybean production. Elemental sulphur is direct source but is too costly. Gypsum is the cheapest source of S. Gypsum not only used as ameliorant for sodic soil but also as S nutrient source for soils and crops. Gypsum and pyrites are being abundantly excavated in the state of Rajasthan, and may be relatively inexpensive as well as more effective.

Gypsum a by product from industry is one of the main sources of calcium and relatively cheaper than other amendments. Its effects on the flocculation of soil particles reflect in the improvements of soil structure and aggregation (Souza *et al*., 2012). Benefits of gypsum in soil physical properties, include increased infiltration, increased soil aggregation, decreased Na adsorption, improved or increased root development and decreased soil compaction. Gypsum contains both S and Ca as secondary nutrients essential for crops. It is known as an excellent source of sulphur for plant nutrition and improves crop yield. Calcium is essential for most nutrients to be absorbed by plants roots. Divalent cation, Ca^{2+} plays a structural role in cell walls and cell membranes. Calcium is present in the apoplast, where it maintains cell and tissue viability. Thus gypsum can improve mineral content in vegetal tissues, such as N, P, K, Ca, Mg, S and Zn. In the present paper, we have reviewed the effect of gypsum as S source on mustard and soybean, two major oilseed crops of India.

Gypsum as source of Sulphur: Gypsum is a naturally occurring sulfate mineral that has been used for many years as a soil conditioner and ameliorant for sodic and heavy clay soils. Gypsum is a cost effective mineral used by the farmer not only as amendment but acts as a nutrient source of Ca (23%) and S (14-16%) for crop growth. Almost 90% of the total (940 million tonnes) of gypsum reserves are located mainly in Jodhpur, Nagaur and Bikaner districts of Rajasthan (Rohtagi *et al*. 1977). Gypsum is the neutral salt of a strong acid and strong base and does not increase or decrease acidity. Dissolving gypsum in water or soil results in the following reaction:

$$CaSO_4 \cdot 2H_2O = Ca^{2+} + SO_4^{2-} + 2H_2O$$

Gypsum adds calcium ions (Ca^{2+}) and sulphate ions (SO_4^{2-}), but does not add or take away hydrogen ions (H^+). Therefore, it does not act as a liming or acidifying material. The Ca^{2+} ions simply interact with exchange sites in soil and sulphate remains dissolved in soil water. Gypsum application in sodic soils having high quantities of sodium counters the harmful effects of salts and helps to improve the soil physical health. Gypsum application in the soil decreases the soil pH, ECe and sodium adsorption ration (SAR) as well as to supports the crop growth. Many, recent research has shown that utility of gypsum can be extended to acid, infertile soils as an ameliorant for sub soil acidity, surface crusting and source of Ca and S for crops.

Another amendment available in market as alternative to gypsum is phosphogypsum (PG). Phosphogypsum is the by product available from industries manufacturing phosphoric acid by wet process in which rock phosphate is treated with sulphuric acid. Phosphogypsum is a valuable material for use in agriculture as it contains some quantities of phosphorus besides sulphur and calcium. Sulphur dose of most of the crops in India ranged between 20 to 60 kg ha^{-1} except sugarcane which profitably responded at 80 kg ha^{-1}. Basal soil application of gypsum and phosphogypsum were found to be superior than that of pyrites (Singh and Singh, 2016).

Effect of gypsum on biometric parameters and yield: Gypsum although relatively less soluble, is a good source of S fertilization to oilseed crops. Gypsum as sulphur source significantly improved grain and stover yield of mustard compared to that of other S sources like elemental S and iron pyrite (Kumar *et al.*, 1997). Gypsum applications (250 kg/ha) reflected in significant improvement in yield attributes and seed yield of Indian mustard (Rao and Shaktawat, 2002). Applications of 40 and 60 kg ha^{-1} S gave significantly higher yield and quality (protein and oil contents in seed) over 20 kg ha^{-1} and no S applications. Similarly application of phosphogypsum (15% S) enhanced soybean yield by 42% over control. Application of S benefits more than one crop grown in sequence and produces a significant residual response. Residual response depends on rate of S application, nature of S source, and the crop being grown. Significant direct and residual response of added S in mustard–black gram and groundnut–mustard cropping systems was observed by Singh and Sarkar (2013).

Application of gypsum improves several biometric parameters of mustard and soybean crop. Significant increase in plant height with the increasing levels of sulphur is attributed to increased metabolic uses of sulphur in plants which seems to have promoted meristematic activities

resulting in higher apical growth and expansion of photosynthetic surface (Piri *et al.,* 2012). Sulphur also influence the dry matter content of oilseed crop by stimulating the chloroplast protein synthesis and higher synthesis of chloroplast results in greater photosynthetic efficiency and ultimately increased dry matter production per plant. Application of sulphur @ 60 kg ha^{-1} as gypsum resulted in the significantly higher biometric parameters *viz.*, plant height, number of primary and secondary branches per plant, number of siliqua per plant and test weight of mustard in a study by Sipai *et al.* (2015).

Gypsum is used as an amendment in sodic soil mainly as an aggregate agent and as a sulphur fertilizer for crops. Field application of gypsum @ 100% G.R to mustard genotypes improved soil physical health as well as the crop growth. The results of the study revealed that germination percentage, plant height, 1000 grain weight and grain yield were maximum in ameliorated than non-ameliorated soil during all the three years (Sadiq *et al.,* 2002). Application of gypsum with organic manures is a less expensive alternative not only to improve soil condition but will enhance crop yields. The addition of gypsum and organic matter to the saline and sodic soils has a synergistic effect between the two antagonists especially for monovalent cations such as Na^+ (Mahmoodabadi *et al.,* 2012). Gypsum in conjunction with cow manure act as ameliorant to increase crop production under salt stress or saline conditions. Application of cow manure and gypsum significantly increased leaf chlorophyll index, improved soybean yield. In a study by Hosmath *et al.* (2014), 20 kg S ha^{-1} applied in the form of gypsum improved the yield of soybean by 12%. The oil content and quality also improved with application of S along with other nutrients. Soil moisture use decreased with increased level of gypsum which indicates better utilization and storage soil moisture during the growth period. The studies of gypsum and its effect on mustard and soybean p and the role of gypsum on oilseed production, nutrient interaction is illustrated in Table 1.

Effect of gypsum on oil and protein content: Nutritionally, *Brassica* species require more sulphur during their growth (Zhao *et al.,* 1993), for the synthesis of both protein and naturally occurring glucosinolates. Both sulphur uptake and sulphur translocation in oilseeds vary as a function of growth stage and plant part. Mustard seed contains about 37 to 49 per cent oil in the seed. Sulphur is not only required for oil production, but needed for development of cell and increases cold resistance and drought hardiness of plant (Patel *et al*. 1992). Increased oil content by S nutrition may be attributed to direct involvement of this element in oil synthesis, as it is a constituent of mustard oil (glucosides and glucosinolates). Being a constituent of some amino acids, sulphur promotes the biosynthesis of proteins and oil in soybean. In a study it was observed that protein content in soybean crop improved by gypsum application @ 40kg S ha^{-1}. Application of Zn along with S nutrient also improves oil content of soybean by activating the enzymes for oil synthesis (Sonune *et al.,* 2001).

Nitrogen and sulphur both are involved in plant protein synthesis. The shortage in sulphur supply for crops decreases the N-use efficiency of fertilizers. Sulphur is an integral part of sulphur - containing amino acids and is required for the S-containing compounds, hence improved protein as well as oil synthesis in oilseeds is also pre requisite for mustard crop. Application of gypsum is known to improve not only oil content but protein content of the crop. In a study reported by Adkine *et al.* (2017), 18 to 20 per cent increase in protein content of mustard seeds was observed with 54 kg gypsum. Protein content of mustard seed was significantly influenced by application of zinc sulphate and gypsum.

In soybean pink root nodule color indicates active N fixation by nitrogenase enzyme. According to Norton (2008) nitrogenase molecule that is causing pink functioning color contains 28 sulphur atoms. If the soil does not have optimum sulphur levels, then it will effect N fixation in subsequent crops as well. Application of gypsum will not only boost N availability when manure is added but will also reduce ammonia volatilization.

Interaction of gypsum with other nutrients: Nutrient interaction is very critical for crop development and productivity. Beneficial effect of gypsum on yield attributes seems to be due to better availability of N, K and S and their translocation, which reflects in terms of increased yield attributes of the crop. A strong interaction of S and N for seed yields in mustard and soybean has been reported by many workers. Lack of S limits the efficiency of added N (Fazili *et al.,* 2008) therefore, S addition becomes necessary to achieve maximum efficiency of applied nitrogenous fertilizer. Mustard crop under field conditions recovered 27-31% of added S without N, but 37-38% with 60 kg N ha^{-1} (Sachdev and Deb, 1990). A shortage in the S supply to the crops lowers the utilization of the available soil nitrogen, thereby increasing nitrate leaching. The N:S ratio that ensures optimum yield and quality of the crop, and unbalanced fertilizer use adversely affects crop production. Sulphur deficiency causes profound changes in N metabolism with reduced protein synthesis and accumulation of soluble organic and inorganic nitrogenous compounds (Jamal *et al.* 2010). Kumar *et al*. (2002) revealed that the highest nitrogen uptake was recorded with the application of 60 kg S ha^{-1} at all the growth stages and by seeds. The interaction between N and S was synergistic and hence application of sulphur increases the concentration and uptake of nitrogen. Najar *et al*.(2011) reported significant increased the concentration of N, P, S and Mg in stover and seed of soybean over control with application of S. Significant effect of sulphur and

Table 1: Survey studies of gypsum on crop yield, quality parameters, and nutrient interaction studies in India on some oilseed crops

Crop	Gypsum rate	Time elapsed after gypsum application	Effect of gypsum on yield	Effect of gypsum on oil, protein content	Gypsum interaction with other nutrients	Title	Reference
Mustard	0, 18, 36 and 54 kg S ha^{-1} and ZnSO4 @0, 5 and 10 kg ha^{-1}	One year	Increase in seed and stover yield of mustard were recorded with application of gypsum @ 36 kg $ha^{-1}$and zinc sulphate @ 5 kg ha^{-1}.	Highest oil and protein content was observed with the application of gypsum and zinc sulphate	Gypsum and zinc sulphate improve the quality of seed in mustard by increasing oil and protein content	Effect of Gypsum and Zinc Sulphate Application on Yield and Quality of Mustard in Vertisol	Adkine *et al.* (2017)
Mustard	0, 20, 40, 60 and 80 kg S ha^{-1}) and zinc (0 2.5, 5.0, 7.5, and 10.0 kh ha^{-1}	2 years	Improvement in mustard yield	Oil content and oil yield improved significantly under the application of 40 kg S ha^{-1} but the protein content was only up to 20 kg ha^{-1}	Positive interaction of S and Zn indicated a marked increase in P content of stover	Effect of sulphur and zinc fertilization on growth, yield and nutrient uptake by mustard [Brasica juncea (L.) Czern. & Coss.] on Ustochrepts	Jat, (2004)
Mustard	S@20, 40 and 60 kg ha^{-1} as Gypsum and Magnesium sulphate	1 year	Significant effect on grain yield and total biological yield, efficiency of both the sulphur fertilizers was comparable	Oil yield improved	-	Efficacy of gypsum and magnesium sulphate as S source to rapeseed in lateritic soil	Dash and Ghosh, (2012)
Mustard	2 and 4 t ha^{-1} gypsum; 20 and 40ppm elemental S	2 year	Gypsum @ 4 t ha^{-1} alon with Zn, Fe produced highest seed and stover yield	-	Synergistic interaction of S, Zn and Fe was observed in red loam soils	Effect of micronutrients, sulphur and gypsum on soil fertility and yield of mustard in ked loam soils of Mewar (Rajasthan)	Akbari *et al.* (2003)
Soybean Chick pea	1, 1.5, 2, 2.5, 3 and 5 t ha^{-1}	1 year	Highest yield and moisture use efficiency in soybean and gram ; Favourable impact on hydraulic conductivity Increase in yield		-	Effect of gypsum on moisture availability in vertisols under soybean gram sequence	Wakode *et al.* (2011)
Soybean	Phosphogypsum @ 60 kg S ha^{-1}				-	Sulphur Management for Optimizing Oilseed and Pulse Production in Rain-fed Jharkhand	Singh and Sarkar, (2013)
Soybean	0, 10, 20, 30, and 40 kg ha^{-1} S applied	2 years	Increase on seed yield	Higher oil content was recorded	-	Sulphur Nutrition in Soybean [Glycine max (L.) Merril] in India	Hosmath *et al.* (2014)

Table 1 continue.....

Table 1 continue.....

						Critical plant sulphur content and effect of sulphur application on grain and oil yield of rainfed soybean in Vertic Ustochrepts	Ganeshmurthy, (1996)
Soybean	40kg S ha^{-1}	2 years	Increased crop yield	Improved oil content	-		
						Productivity and quality of soybean as influenced by levels of N and S nutrition	Bhosagi, (2013)
Soybean	0, 20, 40 kg Sha^{-1} and N @ 30, 40, 50 kg ha^{-1}	1 year	Increased crop yield	Improved oil and protein content	Synergistic interaction of S and N		
						Effect of sulphur and zinc on nutrient uptake and yield of soybean	Pabel and Patil, (2011)
Soybean	0, 10, 20 30 kg S ha^{-1} and 2.5 kg Zn ha^{-1}	1 year	Higher grain and straw yield		Synergistic effect was observed		

nitrogen, when applied together, helps to increase the growth characteristics, yield components and seed and oil yield of soybean crop (Jamal *et al.*2005).

In a study by Rajput *et al.* (2018) significant interaction of N and S was observed in mustard crops resulted in higher crop yield. Sulphur levels showed significant effect on total nitrogen uptake by crop. Application of gypsum as S source @ 40 kg S ha^{-1} in conjunction with zinc @ 5.0 kg ha^{-1} helped in increasing the productivity of mustard (Sipai *et al.*, 2015). The synergistic effect of Zn and S is attributed to its great importance in growth and development as it involves in various enzyme systems as prosthetic group and metallic constituents, in photosynthetic pigment biosynthesis and biosynthesis of auxin which in turn enabled the plant to grow taller and produce more dry matter. The favourable effects of both the nutrients thus led to increased translocation of photosynthates towards seeds resulting in formation of bold seeds.

Effect of gypsum application on soil quality: Gypsum is considered as a multi tasking soil amendment. Gypsum not only provides nutrients like S and Ca to crops but reduces soil erosion and improves soil structure. Some of the important functions of gypsum on soil properties are depicted in Table 2. Most of the studies where gypsum was used as an amendment in improving soil properties have been reported from many countries. Surface sealing and soil crusting are common in many agricultural soils which often increase surface erosion and runoff. Research indicates that certain soil amendments can aid in remediating soils, resulting in higher yields and reduced sediment runoff. Gypsum improved soil structure of silt loam soil by decreasing the soil bulk density, reduced penetrometer resistance at 600 mm depth, lowering compaction of soil. Gypsum improves the physical properties of heavy clay and sodic soils (Chen and Dick, 2011). When gypsum as an electrolyte is applied to soil surface, it increases electrolyte concentration in soil solution and counter the chemical aspect and reduce soil movement cause by erosion. On a silty loam soil application of gypsum reduced soil loss during a 2.5 inch per hour rain by more than 85% (Norton, 2008). In another study gypsum application reduced water runoff by 17%, soil loss by 60% and phosphorus loss by 67% as compared to control. These studies were carried out by USDA-ARS stations where gypsum was considered as cheapest source for reducing soluble P in runoff to nearby water bodies.

Effect of gypsum on soil properties were also documented in many research studies. Soils with high clay content which can open deep cracks in soil profile can be amended with gypsum which keeps the soils from drying out and developing cracks. Irrigated water and rain water will go to root zone instead lost to deep cracks. Gypsum treated soil become more friable, loose making seedling

emergence more uniform in surface crusted soils. Gypsum application in very acidic soils is also very beneficial for crop roots to fight against aluminium toxicity especially in sub soil zone (Ostendrof, 2009). In Na afflicted soils, gypsum applied at the soil surface increases the electrolyte concentration of the infiltrating rainwater, compresses the electric double layer, and provides Ca to the exchange complex where it has selectivity over Mg and Na in soils (Dontsova and Norton, 2002). The beneficial effects of gypsum on erosion control by increasing infiltration and reducing runoff, surface sealing, and crusting have been shown in several studies (Norton and Zhang, 1998). Calcium in gypsum binds soil particles into more effective aggregates that help with water infiltration (Walworth, 2006). By improving soil structure, gypsum helps in preventing soil particulate dispersion, decreases surface crust formation, aids in seedling emergence, increases water infiltration, and decreases the loss of soil and nutrients due to surface runoff and erosion (Chen and Dick, 2011). When gypsum applied to fields under no-till and reduce till practices, it was found to decrease erosion and runoff (Norton, 2008). The main effect of gypsum on soil erosion is due to the reduced capacity of runoff water to cause soil loss. Gypsum reduces runoff volume and may increase surface roughness and the tortuosity of the flow paths to reduce soil loss (Shainberg *et al.*, 1989). Gypsum reduces water dispersible clay, ESP, pH, exchangeable sodium and Mg content of soil. Improvement in hydraulic conductivity, exchangeable Ca and Ca/Mg ratio was found with higher level of gypsum. Increased in moisture storage in sub soil plots were also observed in gypsum applied plots (Wakode *et al.*, 2011).

The application of gypsum reduces the amount of nitrogen fertilizer needed for producing higher corn yields, making gypsum economically advantageous while reducing the amount of fertilizer runoff (Chen *et al.*, 2008). In another study by Favaretto *et al.* (2006) gypsum amendment reduced the concentration of NH_4–N in runoff 4.7-fold when compared with the control. This result likely reflects the decrease in runoff and increase in infiltration caused by gypsum addition because runoff affects the dissolution-desorption of NH_4^+ from the soil, whereas infiltration affects the leaching of NH_4^+ from the soil profile. They reported water-extractable P concentration in sediment was significantly lower in the gypsum treatment compared with the control. Stout *et al.* (2000) found that several coal combustion by-products (gypsum-like materials) had a greater effect on water-extractable P than on Bray-1 P and Mehlich-III P levels, suggesting that, in the short term, Ca may be more important than pH or liming effects in reducing P solubility in soil.

CONCLUSION AND RESEARCH GAPS

With regard to improvement in crop yield, oil and protein content lot of studies have been cited. However, effect of gypsum on nutrient cycling, soil erosion, surface crusting and runoff studies is meagre for Indian soils. Gypsum sources have both positive and negative impact which should be carefully evaluated for site specific objective, region and circumstances. In oilseed crop for increasing yield, no one has yet offered a suitable recommendation that considers different soil type, rainfall, temperature, crops, and cropping systems. Regarding yield response from improvements in

Table 2: Effect of gypsum on soil physical, chemical and biological properties.

Gypsum	Impact on chemical properties
Work as nutrient source for crops	a) Supply S and Ca nutrient to crops
	b) Alleviating sub soil acidity
Acts as an amendment in acid soil	c) Improves base saturation by reducing acid saturation
	d) Decrease P solubility by association with Ca and reduce potential for P pollution
	e) Decrease N and P losses through runoff from fields
	f) Compress electric double layer provides Ca to the exchange complex and enhance clay flocculation
	g) Reduce exchangeable Na content in sodic soils
	Impact on physical properties
Work as an amendment, improves electrolyte concentration of soil solution	a) Bulk density of soil is improved
	b) Swelling and dispersion of clay
	c) Reduce soil compaction
	d) Benefit soil structure
	e) Macroporosity and aggregate stability
	f) Increasing soil aggregation and structural stability canresult in increased infiltration and decreased runoff
	g) Improves soil moisture storage capacity
	h) Indirect effect by improving rooting depth of crops leading to greater sub soil aggregation
	Impact on biological properties
Works as soil ameliorant	a) Improve earth worm population in cultivable soil
	b) Improve soil microbial biodiversity

soil characteristics, due to gypsum application needed for testing their approach in different regions of the country.

Soybean and mustard are high value energy crops and its productivity is often limited by the low availability of essential nutrients or imbalanced nutrition, forming one of the important constraints to oilseed productivity in India. Gypsum an inexpensive, high quality product is easily available S source that can be incorporated with other nutrients can improve crop quality, yield attributes and crop productivity. Along with nutrient supply to the crops, gypsum enhances other nutrient uptake from the soil solution and facilitates nitrogen fixation in soybean crop. Gypsum due to the solubility improves soil physical properties like soil aggregation, reduces bulk density, increase soil moisture retention, and improves water infiltration and decrease soil erosion and runoff. Gypsum thus serves the purpose of supplying secondary nutrient like Ca and S to oilseed crops and improves soil quality by preserving it against detrimental forces of erosion.

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