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Effect of Gypsum Application on Groundnut Growth and Nodules under Rain Fed Condition

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ABSTRACT

Groundnut is called as the King of oil seeds. It is one of the most important food and cash crops of our country. The groundnut (seeds) was sown under rain fed conditions at NARC field research area. Gypsum application was applied at the rate of 0%, 25%, 50%, 75% and 100% gypsum requirement of the experimental field having soil ECe= 0.34dSm^{-1} and pH=7.71. Randomized complete block design was applied with three replications. Growth and nodules data were collected from the experiment. Root length of ground nut plant was significantly differed among gypsum treatments, 50% gypsum requirement application showed maximum root length. 25%, 50%, and 75% gypsum application regarding shoot length presented statistically at par with each other but gypsum application showed better shoot length than without gypsum. The highest root biomass (9.2 gm) was received by 50% gypsum that was statistically at par with the root biomass of 100% gypsum. Maximum shoot biomass was gained with 50% gypsum applied treatment. Gypsum application increased number of leaves per plant. 50% gypsum treated plants attained the highest number of nodules that was statistically at par with 25% gypsum treated plants. 75 and 100% gypsum applied plants depicted statistically same findings with one another but were higher nodule number than control. The effect of gypsum on nitrogen and protein contents of groundnut straw and nut was directly proportional to gypsum dose. These contents were improved as well as the gypsum percentage increased. Increase over control in nitrogen contents and protein was the top (6.9%) in 100% gypsum. Similar trend was also noted in groundnut nut nitrogen and protein.

Keywords: *Calcium, Sulfur, Groundnut, growth, yield, Nitrogen and Protein contents*

INTRODUCTION

The groundnut (*Arachis hypogaea)* is also known as peanut, taxonomically_classified as, a legume crop grown mainly for its edible seeds. It is widely grown in the tropics and subtropics, being important to both small and large commercial producers. It is classified as both a grain legume and, because of its high oil content, an oil crop. World annual production of shelled peanuts was 42 million tonnes in 2014. Atypically among crop plants, peanut pods develop underground rather than aboveground. It is this characteristic that the botanist Linnaeus used to assign the specific name *hypogaea*, which means "under the earth." It is also known as the sovereign of oil seeds. It is one of the most imperative food and cash crops of our country. It is an economical product having a precious source of every one nutrient. Groundnut is furthermore known as wonder nut and poor men's cashew nut. It is highly nutritious owing to 50% edible oil and 25% protein. It is used moreover as shelled nut or in the form of edible oil, or different other forms subject to various degrees of processing such as peanut butter, sauce, flour, or confectionery items. Groundnut cake or flour is a priceless feature in developing countries.

Gypsum is one of the earliest forms of fertilizer used in the United States. It has been applied to agricultural soils for more than 250 years. Gypsum is a moderately soluble source of the essential plant nutrients, calcium and sulfur, and can improve overall plant growth.

Gypsum is a soluble source of the essential plant nutrients, calcium and sulfur, and can improve overall plant growth. Gypsum amendments can also improve the physical properties of some soils (especially heavy clay soils). Such amendments promote soil aggregation and can help prevent dispersion of soil particles, reduce surface crust formation, and promote seedling emergence, and increase water infiltration rates and movement through the soil profile. It can also reduce erosion losses of soils and nutrients and reduce concentrations of soluble phosphorus in surface water runoff. Chemical properties improved by application of gypsum include the mitigation of subsoil acidity and aluminum toxicity. This enhances deep rooting and the ability of plants to take up adequate supplies of water and nutrients during drought periods.

To make recommendations for gypsum use in agriculture, it is important that we have a good understanding of its composition and properties. Composition of pure gypsum ($CaSO_4.2H_2O$) is 79% calcium sulfate ($CaSO_4$) and 21% water (H_2O). Pure gypsum contains 23.3% calcium (Ca) and 18.6% sulfur (S). Gypsum is moderately soluble in water (2.5 g per L) or approximately 200 times greater than lime ($CaCO_3$). This makes the calcium in gypsum more mobile than the calcium in lime and allows it to more easily move through the soil profile.

Calcium moves very slowly, if at all, from one plant part to another and fruits at the end of the transport system get too little. Calcium must, therefore, be constantly available to the roots. Additions to soil of a good source of calcium, such as gypsum, can improve the quality of horticultural crops (Sumner and Larrimore, 2006).

Application of gypsum can reduce dispersion and promote flocculation of soils. Flocculation is a necessary condition for the formation and stabilization of soil structure. This increases water infiltration and percolation (Norton, 2008), thus reducing soil erosion and improving water quality.

Gypsum helps reduce the dispersion of the clay that leads to surface crust formation and also slows the rate of surface drying (Norton and Rhoton, 2007; Rao and Shaktawat, 2001).

Clay dispersion is caused by the mutual repulsion between the clay particles, which results from the presence of extensive negative electric fields surrounding those (Dontsova *et al.,* 2004). Flocculation is a necessary condition for the formation and stabilization of soil structure. This increases water infiltration and percolation (Norton, 2008), thus reducing soil erosion and improving water quality.

Mean alfalfa yields were increased 4.6% in 2001 and 6.2% in 2002 with sulfur treatments compared to the untreated control. These results were statistically significant at the $P \leq 0.05$ level (Chen *et al.,* 2005).

Calcium and sulfur as main nutrients also act significant position in raising yield and efficiency of groundnut. Sulfur is incredibly vital for the creation of amino acids with sulfur and oil production and it also enhances yield as well as quality (Kalamkar, 2006). Calcium nutrition as a produce off-putting issue for groundnut yield is too measured. Engrossed calcium by the roots is not appearing in the budding pod while pod formation calcium mandatory is immersed openly from soil solution. The normal soil has showed for favourable response as compared to salt affected soils (Ahmed *et al.,* 2001).

Materials and Methods

The peanuts (seeds) were sown under rain fed conditions at NARC field research area. Gypsum application was applied at the rate of 0%, 25%, 50%, 75% and 100% gypsum requirement of the experimental field having soil ECe =0.34 dSm^{-1} and pH=7.71. Randomized complete block design was applied with three replications. Growth and nodules data were collected from the experiment. The soil samples collected for physic-chemical analysis was carried out following the method described by Ryan *et al.* (2001).Plant samples collected for total N was measured through sulphuric acid digestion. For distillation Micro-Kjeldahl method (AOAC, 1994) was used. The data thus obtained were subjected to statistical analysis according to Gomez and Gomez (1994).

Results and Discussions

Groundnut growth was significantly affected with gypsum application (table 1). Root length of ground nut plant was significantly differed among gypsum treatments, 50% gypsum requirement application showed maximum root length (18.5 cm) followed 75% and 100 % gypsum requirement that are statistically at par with each other. Lowest root length (13.2 cm) was attained by 0% gypsum. Gypsum @ 200 kg ha^{1} significantly increased growth and yield of groundnut (Ramjeet *et al.,* 2014). Synergistic consequence of Ca and S may be attributable to consumption hefty amounts of nutrients in the course of their glowing improved root system and nodules that valor boast resulted in plant development as well as straw yield at ripeness (Mandal *et al.,* 2005).

Shoot length performed better results with gypsum application mentioned in table-1. 25%, 50%, and 75% gypsum application regarding shoot length presented statistically at par with each other but gypsum application showed better shoot length than without gypsum. A field experiment involving four levels of sulfur (S; 0, 15, 30, and 45 kg ha^{-1}) and three sources [elemental S, gypsum, and ammonium sulfate] significantly increased contents of all the S fractions compared to no S application and which decreased with crop growth. Correlations between the S fractions indicated significant positive relations (Diwakar, 2014).The highest root biomass (9.2 gm) was received by 50% gypsum that was statistically at par with the root biomass of 100% gypsum. Regarding shoot biomass, the maximum (161 gm) was gained with 50% gypsum applied treatment that was statistically equal to 75% and 100% gypsum. Control treatment determined lowest shoot biomass. 25% and 50% gypsum treatment showed statistical results at par with one another. Gypsum application increased number of leaves per plant as indicated in without gypsum treatment.

The raise in branches number valor be attributed to superior root development owing to sulfur, which in turn activated privileged assimilation of N, P, K and sulfur from soil and improved metabolic activity inside the plant (Kalaiyarasan *et al.*, 2003; Salke *et al.*, 2010).Nodulation is the main criteria for the enhancement of yield in leguminous crop.

Table1. *Effect of Gypsum on Growth and Nodulation of Groundnut (Plant-1)*

Treatments	Root length (cm)	Shoot length (cm)	Root biomass (gm)	Shoot biomass (gm)	# of leaves	# of nodules
T_1	13.2c	37b	4.1b	92ab	224a	163b
T_2	15.0ab	42a	5.2ab	95 ab	362a	209a
T_3	18.5a	45a	9.2a	161a	367a	287a
T_4	14.8b	41a	4.5b	143a	342ab	183b
T_5	14.8b	38ab	5.0a	108a	284c	188b
LSD(0.05)	3.6	4.0	4.2	55	23	102

Values followed by same letter(s) are statistically similar at P=0.05 level of significance

T_1=0% of gypsum requirement T_2=25% of gypsum requirement T_3=50% of gypsum requirement T_4=75% of gypsum requirement T_5=100% of gypsum requirement

Significant results were indicated in table-1 regarding number of nodules per plant. However, 50% gypsum treated plants attained the highest number of nodules (287) that was statistically at par with 25% gypsum treated plants. 75 and 100% gypsum applied plants depicted statistically same findings with one another but were higher nodule number than control. Sounda *et al.* (2005) exerted comparable things on the escalation and nodulation of groundnut. Salke *et al.* (2010) reported nodule number per plant and nodule dry weight per plant greater than before as well as Ca rate increased by gypsum application. Groundnut production was enhanced with the use of increased fertilizer having sulfur and calcium nutrients e.g. single super phosphate, elemental sulfur, gypsum and also ammonium sulfate in the alkali soils (Maccio *et al.*, 2003). Murata, (2003) expressed that gypsum application can help to amplify peanut productions in years with high potential yield by Ca availability enhancement in the fruiting zone. Higher groundnut produce was attained with gypsum application than without gypsum treatment. Groundnut pod yield increases significantly with the application of gypsum at 500 kg $ha^{-1}$for both local and improved (chakori) varieties of groundnut (Hussain *et al.*, 2012). Integration of 60 kg K_2O + 45 kg S + 60 kg Ca with 20 kg N + 30 kg P_2O_5 ha^{-1} increased groundnut production during summer season (Singh, (2007).Sulfur (S) and foliar spraying with micronutrient (Zn and B) together had the significant effect on peanut seed yield and its attributes as well as seed quality (Abd and Mona, 2013). Gypsum resulted in higher groundnut yield compared to unfertilized treatment (Rumbidzai and Chamunorwa,2014). The kernel-S, Ca and Mg concentration improved significantly under gypsum (single or split) application increased total uptake of all nutrients and thereby pod and haulm yield of groundnut (Rao and Shaktawat, 2005). Gypsum alone or in combination with NPK fertilizer increased pod yield from 23.21% to 62.65% in different gypsum amended plots as compared to check (Cheema *et al.*, 1991).Gypsum 250kg at sowing + 125kg ha^{-1} at flowering significantly increased pods number $plant^{-1}$, seed index, shelling per cent, pod & kernel yield and harvest index of groundnut *(Arachis hypogaea L.*) over lower levels and control (Jat and Singh, 2006). Different sources of sulfur significantly influenced number and dry weight of nodules and groundnut seed yield. The interaction between irrigation levels and sources of sulfur was significant on groundnut yield and with gypsum was the best. Gypsum was the best performer in this regard (Dey, 2007).Maximum pods number plant^{-1} (34.2) and pod length (1.907 cm) of gram (*Cicer arietinum*) was recorded in plots treated with 500 kgha^{-1} gypsum (Humayoon, 2001). The results revealed that application of NPK (20:10:25 kg ha^{-1}) + gypsum (250 kg ha^{-1}) +$ZnSO_4$ (25 kg ha^{-1}) recorded significantly higher pod and haulm yield in groundnut (Parvathi *et al.,* 2015). The increase in grain yield of sesame was found to be 14.3% due to 250 kg gypsum ha^{-1} over no gypsum application (Sangeetha *et al.,* 2016). 300 kg ha^{-1} gypsum application gave high seed yield of groundnut with full dose of NPK fertilizers alone or reduced dose of NPK fertilizers and 10 t FYM ha^{-1} (Thayamini, 2016). Application of gypsum @250 kg ha^{-1} changed the soil pH from 4.1 to 5.0 and increased the mean pod dry weight from 618 to 865 g with high quality kernels (Thilakarathna, *et al.,* 2014).

Table2. *Effect of Gypsum on Nitrogen and protein contents (%) of groundnut straw and Nut*

Treatment	Groundnut Straw (%)			Groundnut Seed (%)		
	Nitrogen	Protein	Increase over control	Nitrogen	Protein	Increase over control
T_1	0.498	3.11	------------	3.000	18.75	----------
T_2	0.592	3.70	1.9	3.247	20.29	8.2
T_3	0.790	4.94	5.9	3.282	20.51	9.4
T_4	0.890	5.06	6.3	3.353	20.96	11.7
T_5	0.842	5.25	6.9	3.489	21.80	16.3

T_1=0% of gypsum requirement T_2=25% of gypsum requirement T_3=50% of gypsum requirement T_4=75% of gypsum requirement T_5=100% of gypsum requirement

The effect of gypsum on nitrogen and protein contents of groundnut straw and seed was directly proportional to gypsum dose (Table-2). These contents were improved as well as the gypsum percentage increased. Increase over control in nitrogen contents and protein was the top (6.9%) in 100% gypsum. Similar trend was also noted in groundnut seed regarding nitrogen and protein. Gypsum treatments significantly increased the harvest index of groundnut on pooled basis. Oil and protein contents of groundnut kernel increased significantly under gypsum treatments (Rao *et al.,* 2001). Application 40kgha^{-1}sulphur as gypsum source significantly increased the nitrogen, phosphorus, potash and sulphur uptake by the groundnut crop over their controls (Poonia *et al.,* 2013).

Conclusion

100% gypsum increased the growth parameters and improved the quality of peanut under rainfed conditions due to enrichment of calcium and sulfur in plants as well as soil.

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