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# Effect of ferrogypsum on yield, nutrient uptake and quality in groundnut

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**Abstract** : The present investigation was undertaken to study the efficacy of ferrogypsum on yield, quality and nutrient uptake in groundnut. Ferrogypsum is a byproduct from the titanium industry and it contains gypsum (52.63%) and iron (10.24% as $Fe_2O_3$). Field experiment was conducted on a calcareous red soil with groundnut to evaluate the efficacy of ferrogypsum in comparison with gypsum + $FeSO_4$ (as soil application and foliar spray). The results revealed that application of ferrogypsum in amounts equivalent to recommended dose (400 kg/ha) of gypsum significantly increased the pod and haulm yield, quality, nutrient content and uptake in groundnut. This beneficial effect was similar to those obtained with the application of gypsum + $FeSO_4$ (FeSO4 as either soil applicztion of foliar spray). Thus the results of the present study indicated that ferrogypsum was as effective as gypsum in increasing pod, haulm yield and oil and protein content and nutrient uptake in groundnut crop grown on a calcareous soil. (*Key words : ferrogypsum, Iron nutrition, Sulphur source*)

Groundnut is one of the most important oil seed crops grown in India. It accounts for about 50% of the 13 m t annual oil seed production in the country. But at present, it's average productivity is only 1,155 kg $ha^{-1}$ against the potential of 3000 kg $ha^{-1}$. Higher yield of groundnut was contributed by optimum nutrient composition and it's uptake from soil. Among the different constraints in groundnut production, lime induced iron chlorosis is the major one especially in calcareous soils where $HCO_3$ ions hinder the uptake and translocation of Fe in the plant (Patel *et al.*, 1993). This lime induced iron chlorosis can be managed by soil application or foliar spray of ferrous sulphate (Singh *et al* 1990). Gypsum is known for its Ca (Ursal *et. al* 1994) and S nutrition (Verma *et al* 1973) in groundnut. Ferrogypsum which is a byproduct from titanium industry, contains five important nutrients, *viz*. Fe (10.24% as $Fe_2O_3$), Ca and S (52.63% as gypsum), Mg (2.64%) and 100 mg $kg^{-1}$ of water soluble K and contain no heavy metals to pose environmental problem. Thus this industrial byproduct can be used to alleviate iron chlorosis in calcareous soil, besides being a nutrient source for groundnut to supply Ca, Mg, S & K. In order to evaluate the effectiveness of ferrogypsum on yield, nutrient uptake and quality in groundnut, the present study was contemplated.

## Materials and Methods

Field experiment was conducted on a calcareous red soil (Udic Ustropept) during August - December, 1998 at Tamil Nadu Agricultural University Farm, Coimbatore. The soil of the experimental site was moderately alkaline (pH 8.5), and low in soluble salts (EC 0.12 $dSm^{-1}$) and the level of free calcium carbonate was 4.55 per cent. $KMnO_4$-N, Olsen-P, $NH_4OAc$-K and $CaCl_2$-S in the initial soil were 148, 7.8, 300 and 25.6 kg $ha^{-1}$, respectively. Exchangeable-Ca and Mg levels were 10.7 and 4.2 cmol $(p+)kg^{-1}$, respectively and DTPA-Fe was 3.6 mg $kg^{-1}$.

There were seven treatments which were replicated thrice in a randomized block design. The treatments consisted of ferrogypsum and gypsum either alone or in combination with either soil applied or foliar sprayed $FeSO_4$, ferrogypsum in amounts to supply Fe in 50 kg of $FeSO_4$ or $FeSO_4$ in amounts to supply Fe in ferrogypsum applied alone, besides a control. These treatments were superimposed over blanket application of 12.5 tonnes $ha^{-1}$ of FYM and recommended doses of N, $P_2O_5$ and $K_2O$, *viz*. 17, 34 and 54 kg $ha^{-1}$, respectively as urea, di-ammonium phosphate and muriate of potash.

The quantity of ferrogypsum was equated to gypsum on the basis of its sulphur content. The calculated quantities of gypsum and ferrogypsum were applied in a single dose at 40th day after sowing to the respective plots. Soil application of 50 kg $FeSO_4$ was made basally. Foliar spray of $FeSO_4$ (1.0% solution along with 0.1% citric acid) was given three times, i.e. on 30th, 40th and 50th day after sowing.

The yield of pods, kernels and haulms were recorded separately at the time of harvest. Kernel, shell and haulm samples were analyzed for total N by following the procedure of microkjeldahl method (Humphries, 1956). In di-acid (nitric and perchloric in 9:4 ratio) digest, total P was estimated by vanadomolybdo phosphoric yellow method (Jackson, 1973), total K by flame photometry (Jackson, 1973), total Ca and Mg by versenate titration (Jackson, 1973) total S by turbidimetry procedure (Chesnin and Yien, 1950) and total micronutrients by atomic adsorption spectrophotometry and the respective total uptake values were computed. The crude protein content in kernel was estimated by multiplying the total nitrogen content of kernel by a factor of 6.25 and the oil content was determined in Nuclear Magnetic Resonance (NMR) spectrometer.

## Results and Discussion

### *Yield and Quality*

The results showed that the pod yield was highest with gypsum + soil applied $FeSO_4$ which was on a par with yield obtained with ferrogypsum as well as gypsum + foliar sprayed $FeSO_4$ (Table 1). However, this trend was not reflected in the case of haulm yield. Haulm yield in gypsum + soil applied $FeSO_4$ treatment was significantly higher than those in other treatments. The yields in plots receiving gypsum + soil applied $FeSO_4$ and ferrogypsum were similar as that of the yield in plot receiving gypsum + foliar sprayed $FeSO_4$. In the case of treatments which received gypsum + $FeSO_4$ in amounts to supply Fe equivalent to the quantity supplied in ferrogypsum, the yield was depressed presumably due to the induced imbalance by the high amount (200 kg $ha^{-1}$) of readily soluble $FeSO_4$. The yield depression in the treatment which received gypsum + ferrogypsum in amounts to supply Fe in 50 kg of $FeSO_4$ may be due to the low solubility of ferrogypsum as compared to $FeSO_4$.

The shelling percentage varied from 58.7 per cent in control to 70 per cent in gypsum + $FeSO_4$(SA) as well as in gypsum + $FeSO_4$(FS) treatments. Excepting control and the treatment which received only gypsum where the shelling percentage was comparatively low (58.7 and 65.0 per cent, respectively), in all other treatments the shelling percentage was significantly increased due to the application of ferrogypsum and/or gypsum + $FeSO_4$. Similar finding was obtained by Kumaran (2000) due to application of gypsum along with inorganic and/or organic fertilizers.

Ferrogypsum application significantly increased the oil content (Table 2) in groundnut by about 12 per cent over control whereas application of gypsum with $FeSO_4$ applied either through soil or foliar spray could increase it by 8 to 9 per cent only. Th protein in groundnut kernel was also significantly influenced by the treatments due to better S and Fe utilization through the application of either $FeSO_4$ or ferrogypsum.

*Nutrient uptake*

The highest N uptake was recorded with gypsum + $FeSO_4$ (Soil applied) treatment which is followed by gypsum + $FeSO_4$ (Foliar sprayed) and ferrogypsum treatment (Table 3). This enhanced N uptake might be due to correction of leaf chlorosis by better Fe nutrition. The findings of Sideris and Young (1956) lend support to this observation. In the present investigation, about 1.6 to 1.8 times increase in N uptake over control was recorded with the application of gypsum + $FeSO_4$ or ferrogypsum. Same trend was also observed in the case of total P uptake. The ferrogypsum application recorded P uptake of 16.8 kg $ha^{-1}$ which is next to gypsum + $FeSO_4$ treatments (18.3 kg $ha^{-1}$). Lokhande *et al* (1998) and Patel *et al* (1993) have observed similar increases in P uptake due to application of $FeSO_4$ in calcareous soils. In the light of this view of non-existence of any antagonistic effect between P and Fe in crop nutrition, the enhanced P uptake observed in the present study in treatments which received Fe in the form of $FeSO_4$ with gypsum and ferrogypsum were justifiable and as evidenced responsible for not limiting groundnut yield. In the case of K too, high uptake was associated with these treatments. Enhanced K uptake was seen in treatments receiving gypsum + $FeSO_4$ and ferrogypsum as compared to other treatments. Raju *et al* (1978) and Ursal *et al* (1994) have recorded significant positive relationship between Fe supply and K uptake incrops.Highest uptake of Ca and Mg was associated with ferrogypsum treatment (Table 3). S uptake was high in gypsum + soil applied $FeSO_4$, followed by gypsum + foliar sprayed $FeSO_4$ and ferrogypsum treatments. These favourable effects could be attributed to the indirect effect of better Fe nutrition in these treatments to enhance growth in groundnut which caused increased uptake of secondary nutrient rather than to any direct influence (Velu, 1977; Pande *et al* 1993; Patel *et al* 1993).

The groundnut plants grown in soils treated with ferrogypsum and gypsum + $FeSO_4$ (soil application or foliar spray) in the present study were under good micronutrients nourishment. The highest iron uptake was associated with gypsum + soil applied $FeSO_4$ followed by ferrogypsum treatments. In general, the treatments which received iron either as ferrogypsum or $FeSO_4$ resulted in higher iron uptake in groundnut. Similar trend was also observed in the case of Mn, Zu and Cu uptake. These observations were similar to those of Krishnappa *et al* (1992) and Lokhande *et al* (1998).

Thus, the results of the present study indicate that the use of ferrogypsum was as effective as the use of gypsum + $FeSO_4$ in incresing pod and haulm yields, nutrients uptake and oil and protein contents in groundnut grown on calcareous soil.

**Table 1.** Effect of treatment on pod, haulm, kernel yields and shelling percentage in groundnut.

| Treatment | Pod Yield (kg $ha^{-1}$) | Haulm Yield (kg $ha^{-1}$) | Shelling Percentage | Kerel Yield (kg $ha^{-1}$) |
|---|---|---|---|---|
| Control | | 1305 | 187458.7 | 765 |
| Gypsum | 1621 | 2066 | 65.0 | 1058 |
| Gypsum + $FeSO_4$ (SA)* | 1929 | 2307 | 70.0 | 1348 |
| Gypsum + $FeSO_4$ (FS)* | 1873 | 2096 | 70.0 | 1317 |
| Ferrogypsum (FG) | 1917 | 2105 | 69.0 | 1322 |
| Gypsum + $FeSO_4$ = FG | 1678 | 2025 | 67.0 | 1124 |
| Gypsum + FG=$FeSO_4$ | 1497 | 1832 | 69.0 | 1032 |
| SE(d) | 63 | 83 | 1.5 | 32 |
| CD(P=0.05) | 137 | 181 | 3.2 | 70 |

**Table 2.** Effect of treatment on oil content, oil yield, nitrogen and protein content in groundnut

| Treatment | Oil Content (%) | Oil Yield (kg $ha^{-1}$) | Nitrogen Content (%) | Protein Content (%) |
|---|---|---|---|---|
| Control | 47.6 | 364 | 3.17 | 19.8 |
| Gypsum | 49.7 | 526 | 3.73 | 23.3 |
| Gypsum + $FeSO_4$ (SA)* | 51.4 | 693 | 4.38 | 27.4 |
| Gypsum + $FeSO_4$ (FS)* | 51.8 | 682 | 4.43 | 27.7 |
| Ferrogypsum (FG) | 53.3 | 705 | 4.02 | 25.1 |
| Gypsum + $FeSO_4$ = FG | 51.6 | 580 | 3.73 | 23.3 |
| Gypsum + $FeSO_4$ | 49.6 | 512 | 4.02 | 25.1 |
| SE(d) | 0.69 | 22 | 0.14 | 0.90 |
| CD(P+)>)%) | 1.44 | 48 | 0.31 | 1.95 |

*SA - Soil Application, *FS - Foliar Spray

Table 3. Effect of treatments on the total uptake of major and secondary nutrients in groundnut

| Treatment | Nitrogen (kg ha$^{-1}$) | Phosphorus (kg ha$^{-1}$) | Pottasium (kg ha$^{-1}$) | Calcium (kg ha$^{-1}$) | Magnesium (kg ha$^{-1}$) | Sulphur (kg ha$^{-1}$) |
|---|---|---|---|---|---|---|
| Control | 59.4 | 11.1 | 35.3 | 36.0 | 7.8 | 5.0 |
| Gypsum | 81.4 | 14.0 | 43.4 | 49.0 | 11.3 | 7.7 |
| Gypsum + $FeSO_4$(SA)* | 106.3 | 18.3 | 51.6 | 59.4 | 13.1 | 10.0 |
| Gypsum + $FeSO_4$(FS)* | 100.3 | 17.8 | 48.0 | 54.4 | 12.2 | 9.8 |
| Ferrogypsum (FG) | 96.1 | 16.8 | 47.9 | 56.7 | 13.0 | 9.6 |
| Gypsum + $FeSO_4$=FG | 80.1 | 15.4 | 43.9 | 48.3 | 10.9 | 8.6 |
| Gypsum + FG=$FeSO_4$ | 78.2 | 14.0 | 39.4 | 45.6 | 10.5 | 7.2 |
| SE(d) | 1.67 | 0.25 | 1.47 | 1.2 | 0.52 | 0.12 |
| CD(P=0.5) | 3.63 | 0.54 | 2.50 | 2.5 | 1.13 | 0.27 |

*SA - Soil Application, *FS - Foliar Spray

Table 4. Effect of treatments on the total uptake of micronutrients in groundnut (g ha$^{-1}$) ✓

| Treatments | Iron | Manganese | Zinc | Coppe |
|---|---|---|---|---|
| Control | 2896 | 370 | 158 | 85 |
| Gypsum | 3349 | 432 | 191 | 91 |
| Gypsum + $FeSO_4$(SA)* | 4352 | 743 | 340 | 138 |
| Gypsum + $FeSO_4$(FS)* | 3767 | 508 | 276 | 114 |
| Ferrogypsum (FG) | 4026 | 755 | 288 | 128 |
| Gypsum + $FeSO_4$=FG | 3690 | 461 | 207 | 99 |
| Gypsum + FG = $FeSO_4$ | 3112 | 519 | 230 | 104 |
| SE(d) | 90 | 10 | 6 | 3 |
| CD(P=0.05) | 195 | 22 | 13 | 5 |

*SA - Soil Application, *FS - Foliar Spray

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