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Responses of Groundnut to Different Levels of Nutrients with Gypsum in Typical Alfisols under Irrigated Condition

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ABSTRACT

India is demand for vegetable oils is escalating rapidly, yet domestic production struggles to keep pace. Groundnut (*Arachis hypogaea* L.), most important oilseed crops pre-dominantly growing, often exhibits low yield due to inadequate nutrient management. A field trial was conducted during late *rabi* season (2024-2025) at SRMCAS, Baburayanpettai, Tamil Nadu, India. The study was investigated a randomized block design with ten treatments combining varying levels of 100% RDF along with gypsum @ 50% basal and 50% at 25, 35 and 45 DAS and 75% RDF along with gypsum @ 50% basal and 50% at 25, 35 and 45 DAS. The groundnut variety GG 7 was used. Growth and yield parameters were measured at 25, 50 and 75 days after sowing and at harvest. The study revealed that the combined application of 100% RDF along with gypsum @ 50% basal and 50% at 45 DAS and 75% RDF along with gypsum @ 50% basal and 50% at 45 DAS significantly increased plant height, DMP, LAI, total chlorophyll index, number of root nodules, number of flowers, pegs, pods per plant and kernels per pod. This treatment was also recorded higher pod yield (2100 and 2031 kg/ha) and haulm yield (5097 and 4952 kg/ha). The study of groundnut crop analysis gives a clear understanding of the nutrient accumulation at different stages of growth of groundnut and this can be utilized for fertilizer supply during critical stages and timely gypsum application ensures the adequate calcium and sulphur availability at peg formation and pod development stage cause micro acidification of soils which slightly lower down the pH of soil and rises the nutrient availability.

Key words: Groundnut, Growth, Gypsum, Nutrient levels, Yield.

The domestic demand for vegetable oils and fats has been rising rapidly, 6% per year, while our local output has been increasing at just about 2% per year. In India, the average yield of oilseeds is extremely low compared to other countries of the world. Groundnut is one of the leading oilseed crops in India and it is abundantly grown under rainfed and irrigated condition in India. Groundnut otherwise called as “King of oilseeds”. It is the prominent and premier oilseed crop of India mainly cultivated for human consumption and animal feed, (Sowmya *et al.,* 2022). India is world leader in groundnut cultivation area with annual all-season coverage of 54.2 lakh hectares. Globally, India occupies second place, both in area and production in the world, with a cultivated area of 47 million hectares and with a production of 103.6p lakh tons and an average productivity of 2136 kg/ha (India Stat, 2024).

In groundnut crop, macronutrients and micronutrients play significant role in improving the pod yield and quality. Nitrogen supports vegetative growth and chlorophyll synthesis, which is primary absorber of light energy needed for photosynthesis, helps in the synthesis of metabolites and its transportation to the seeds (Patel *et al.,* 2022). Phosphorus supports in root enlargement and vigour transfer and potassium contributes to various physiological processes, enhance stress tolerance, improve peg and pod formation and better economic yield.

Sulphur and calcium is the major plant nutrient and an important component of three amino acids which are essential components of proteins and its main prerequisites for enhancing the productivity and quality of groundnut (Kamal *et al.,* 2024). Sulphur and calcium from gypsum plays a crucial role during the reproductive phase, in groundnut crop particularly in peg formation, pod development and seed filling. Calcium is relatively immobile in plants, therefore its direct availability in the root zone and near developing pods. Low calcium content leads to several serious problems for groundnut including the production of undeveloped pods, black embryo in seeds, weak germination of seeds reduces possible of aflatoxin, especially in soil suitable for growth and activity of fungus (*Aspergillus flavus*) and thus decays groundnut pod (Murata,

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2003). Generally, gypsum is composed of calcium sulphate dehydrate ($CaSO_4.2H_2O$) is a frequently used soil amendment and soluble source of calcium and sulphur content are essential nutrients for crop growth and yield. The application of gypsum in the soil which have improve soil structure, reducing soil dispersion, alle*via*ting soil salinity, enhance nutrient availability and reduce aluminum toxicity for plant growth and root development. In the view of the above, the experiment was conducted in typical alfisols under irrigated condition.

The field experiment study was conducted during 2024- 2025 at the SRMCAS (12. 38°N lat. 79. 73°E long). The soil analysis of the trial field was clay loam in texture having pH (7.9), EC (0.2 dS/m), organic carbon (0.3%) with available N (123 kg/ha), available P (53 kg/ha) and available K (150 kg/ha). The groundnut variety GG 7 was select for the study. The experiment was laid out in a randomized block design with triplicates. The treatments consisted of the recommended NPK levels in combination with gypsum, applied in two split doses. The treatment used are: T_1- 100% RDF + Gypsum @ 50% basal and 50% at 25 DAS, T_2 - 100% RDF + Gypsum @ 50% at basal and 50% at 35 DAS, T_3 - 100% RDF + Gypsum @ 50% basal and 50% at 45 DAS, T_4 - 75% RDF + Gypsum @ 50% basal and 50% at 25 DAS, T_5 - 75% RDF + Gypsum @ 50% basal and 50% at 35DAS, T_6 - 75% RDF + Gypsum @ 50% basal and 50% at 45 DAS, T_7 - 100% RDF + Gypsum @ 100% as basal application, T_8 - 100% RDF + Gypsum @ 100% at 25 DAS, T_9 - 75% RDF + Gypsum @ 100% at 25 DAS, T_{10} -Control. According to the TNAU crop production guide (2020), the recommended application rates for N, P and K as 25:50:75 $N:P_2O_5:K_2O$ kg/ha. These nutrient requirements are met through urea, SSP and MOP and gypsum is applied @ 400 kg/ha to supply calcium and sulphur.

The biometric observations, yield and yield attributes were recorded at 25, 50, 75 DAS and at harvest stages. The data were subjected to statistical analysis by analysis of Variance using R-software.

Growth attributes

The growth attributes of groundnut were significantly influenced by different treatments. Among the treatments, the application of 100% RDF + gypsum @ 50% basal and 50% at 45 DAS and 75% RDF + gypsum @ 50% basal and 50% at 45 DAS recorded taller plant height (9.0, 29.9, 39.9, 42.5 cm and 8.7, 29.5, 39.1, 41.8 cm) at 25, 50, 75 DAS and harvest stage (Table 1) due to adequate availability of nutrients along with gypsum promotes robust plant height. The lower plant height was observed in control plot (6.2, 16.5, 26.8 and 30.2 cm).

The maximum dry matter production (766.7, 1966.7, 3733.2, 4591.8 kg/ha and 704.2, 1833.3, 3625.8, 4459.7 kg/ha) was observed with application of 100% RDF + gypsum @ 50% basal and 50% at 45 DAS and 75% RDF + gypsum @ 50% basal and 50% at 45 DAS and the lowest DMP (466.7, 1166.7, 2485.4, 3050.4 kg/ha) was recorded in control at 25, 50, 75 DAS and harvest stage (Table 2) due to synergistic influence of balanced application of NPK fertilizers, along with gypsum improves plant biomass, which enhance photosynthesis and nutrient uptake. The split application of gypsum increasing levels of nitrogen and phosphorus result in higher dry matter production (Brar and Manhas, 2023).

Yield and yield attributes

The nutrient level and time of application had significant influence on number of flowers per plant, number of pegs per plant, number of pods per plant and number of kernels per pod. The higher number of flowers per plant (38.0 and 36.0) was observed with application of 100% RDF+ gypsum @ 50% basal and 50% at 45 DAS and 75% RDF + gypsum @ 50% basal and 50% at 45 DAS and lesser number of flowers (21.0) were recorded in the control plot at 75 DAS, respectively due to sufficient phosphorus and potassium along with calcium from gypsum augmented flower initiation and development. The application of 100% RDF + gypsum @ 50% basal and 50% at 45 DAS and 75% RDF + gypsum @ 50% basal and 50% at 45 DAS recorded

Table 1: Effect of nutrients levels and time of gypsum application on plant height (cm) of groundnut.

Treatments	25 DAS	50 DAS	75 DAS	At harvest
T_1: 100% RDF + Gypsum @ 50% basal and 50% at 25 DAS	7.5	24.0	32.2	37.5
T_2: 100% RDF + Gypsum @ 50% at basal and 50% at 35 DAS	7.4	21.8	30.5	36.0
T_3: 100% RDF + Gypsum @ 50% basal and 50% at 45 DAS	9.0	29.9	39.9	42.5
T_4: 75% RDF + Gypsum @ 50% basal and 50% at 25 DAS	7.6	22.9	30.5	36.9
T_5: 75% RDF + Gypsum @ 50% basal and 50% at 35DAS	7.7	21.6	31.2	35.9
T_6 : 75% RDF + Gypsum @ 50% basal and 50% at 45 DAS	8.7	29.5	39.1	41.8
T_7: 100% RDF + Gypsum @ 100% as basal application	7.1	22.4	31.7	35.8
T_8: 100% RDF + Gypsum @ 100% at 25 DAS	7.8	21.7	30.1	35.6
T_9: 75% RDF + Gypsum @ 100% at 25 DAS	7.1	21.2	30.9	34.9
T_{10}: Control	6.2	16.5	26.8	30.2
CD (P≤0.05)	0.812	2.815	3.582	4.236

RDF- Recommended dose of fertilizer; *Significant at P≤0.05; NS- Non-Significant P≤0.05.

significantly more number of pegs per plant (69.0 and 67.0) at 75 DAS, respectively (Table 3). The lesser number of pegs per plant was observed with the control treatment with a value of 48.0. It might be due to optimal nutrient supply and timely gypsum application supports reproductive development. Bairagi *et al.* (2017) observed same finding.

Application of 100% RDF + gypsum @ 50% basal and 50% at 45 DAS and 75% RDF + gypsum @ 50% basal and 50% at 45 DAS recorded maximum number of pods per plant (33.8 and 32.8) and number of kernels/pod (2.76 and 2.75) due to gypsum improved soil aggregation and reduces surface crusting, which facilities better root penetration and water movement in the soil profile and the minimum number of pods per plant and kernels/pod (23.5 and 2.18) were observed in the control plot, which lacked external nutrient and gypsum application showed significantly reduce pod and kernel numbers possibly due to nutrient deficiency and unfavourable soil physical condition. Sagar *et al.* (2020) that the application of phosphorus along with gypsum @ 400 kg/ha resulted in higher number of pods per plant in groundnut.

Pod and haulm yield

Significantly higher pod yield (2100 and 2031 kg/ha) and haulm yield (5097 and 4952 kg/ha) were registered with the application of 100% RDF + gypsum @ 50% basal and 50% at 45 DAS and 75% RDF + gypsum @ 50% basal and 50% at 45 DAS and the lower pod yield (1154 kg/ha) and haulm yield (3375 kg/ha) were observed in the control treatment (Table 4). The higher pod yield and haulm yield achieved due to nutrient accumulation at different stages of growth of groundnut and this can be utilized during critical stages and timely gypsum application ensures the adequate calcium and sulphur availability at peg formation and pod development stage cause micro acidification of soils which rather lesser the pH of soil and rises the nutrient. Therefore, applying 50% gypsum as basal and 50% at 45 DAS ensures sustained nutrients availability

Table 2: Effect of nutrients levels and time of gypsum application on dry matter production (kg/ha) of groundnut.

Treatments	25 DAS	50 DAS	75 DAS	At harvest
T_1: 100% RDF + Gypsum @ 50% basal and 50% at 25 DAS	636.0	1633.3	3214.0	3953.3
T_2: 100% RDF + Gypsum @ 50% at basal and 50% at 35 DAS	616.5	1566.7	3183.3	3915.5
T_3: 100% RDF + Gypsum @ 50% basal and 50% at 45 DAS	766.7	1966.7	3733.2	4591.8
T_4: 75% RDF + Gypsum @ 50% basal and 50% at 25 DAS	628.5	1533.3	3120.0	3837.6
T_5: 75% RDF + Gypsum @ 50% basal and 50% at 35DAS	615.9	1433.3	3086.7	3796.6
T_6 : 75% RDF + Gypsum @ 50% basal and 50% at 45 DAS	704.7	1833.3	3625.8	4459.7
T_7: 100% RDF + Gypsum @ 100% as basal application	600.0	1600.0	3033.3	3731.0
T_8: 100% RDF + Gypsum @ 100% at 25 DAS	606.7	1466.7	2966.7	3649.0
T_9: 75% RDF + Gypsum @ 100% at 25 DAS	580.0	1400.0	2862.3	3520.6
T_{10}: Control	466.7	1166.7	2485.4	3050.4
CD (P≤0.05)	65.25	177.27	401.99	408.00

RDF- Recommended dose of fertilizer; *Significant at P≤0.05; NS- Non-Significant P≤0.05.

Table 3: Effect of nutrients levels and time of gypsum application on number of flowers/plant, number of pegs/plant, number of pods/plant and number of kernels/pod of groundnut.

Treatments	No. of. flowers/plant	No. of. pegs/plant	No. of. pods/plant	No. of. kernels/pod
T_1:100% RDF + Gypsum @ 50% basal and 50% at 25 DAS	32	60	29.0	2.40
T_2:100% RDF + Gypsum @ 50% at basal and 50% at 35 DAS	29	59	28.9	2.36
T_3:100% RDF + Gypsum @ 50% basal and 50% at 45 DAS	38	69	33.8	2.76
T_4:75% RDF + Gypsum @ 50% basal and 50% at 25 DAS	30	57	27.9	2.32
T_5:75% RDF + Gypsum @ 50% basal and 50% at 35DAS	28	55	27.0	2.20
T_6 :75% RDF + Gypsum @ 50% basal and 50% at 45 DAS	36	67	32.8	2.75
T_7:100% RDF + Gypsum @ 100% as basal application	29	58	28.4	2.60
T_8:100% RDF + Gypsum @ 100% at 25 DAS	28	56	27.4	2.58
T_9:75% RDF + Gypsum @ 100% at 25 DAS	27	54	26.5	2.50
T_{10}:Control	21	48	23.5	2.18
CD (P≤0.05)	3.694	6.861	3.351	0.285

RDF- Recommended dose of fertilizer; *Significant at P≤0.05; NS- Non-Significant P≤0.05.

Table 4: Effect of nutrients levels and time of gypsum application on pod yield (kg/ha) and haulm yield (kg/ha) of groundnut.

Treatments	Pod yield (kg/ha)	Haulm yield (kg/ha)
T_1: 100% RDF + Gypsum @ 50% basal and 50% at 25 DAS	1566	4388
T_2: 100% RDF + Gypsum @ 50% at basal and 50% at 35 DAS	1535	4346
T_3: 100% RDF + Gypsum @ 50% basal and 50% at 45 DAS	2100	5097
T_4: 75% RDF + Gypsum @ 50% basal and 50% at 25 DAS	1458	4260
T_5: 75% RDF + Gypsum @ 50% basal and 50% at 35DAS	1334	4214
T_6 : 75% RDF + Gypsum @ 50% basal and 50% at 45 DAS	2031	4950
T_7: 100% RDF + Gypsum @ 100% as basal application	1663	4242
T_8: 100% RDF + Gypsum @ 100% at 25 DAS	1593	4050
T_9: 75% RDF + Gypsum @ 100% at 25 DAS	1488	3908
T_{10}: Control	1022	3561
CD (P≤0.05)	238.0	499.5

RDF- Recommended dose of fertilizer; *Significant at P≤0.05; NS- Non-Significant P≤0.05.

throughout the critical growth stages. This approach not only supports optimal root zone development early on but also meets the nutrient demands during the reproductive phase, ultimately contributing to sustained growth, higher yields and improved groundnut quality. Similar findings were reported by Balasubramanian *et al*. (2023).

CONCLUSION

The study demonstrates that the combined application 100% RDF along with gypsum @ 50% basal and 50% at 45 DAS and 75% RDF along with gypsum @ 50% basal and 50% at 45 DAS has significantly on par. These treatments enhance the growth and resulted in higher plant height, DMP, LAI, total chlorophyll index, number of root nodules, number of flowers per plant, number of pegs per plant, number of pods per plant number of kernels per pods, pod yield and haulm yield due to synergistic effect of balanced NPK fertilizers and timely gypsum application ensures the availability of essential nutrients, particularly calcium and sulphur during peg formation stage. Therefore, the best treatment application is recommended dose of nutrients along with split application of gypsum for achieving the higher yield and quality groundnut production as sustainable manner.

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Disclaimers

The views and conclusions expressed in this article are solely those of the authors and do not necessarily represent the views of their affiliated institutions.

Informed consent

All animal procedures for experiments were approved by the Committee of Experimental Animal care and handling techniques were approved by the University of Animal Care Committee.

Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this article.

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