

Original Research Article

“Evaluation of varieties and gypsum on growth and yield of groundnut (*Arachis hypogaea*)”

ABSTRACT

Comment [MP1]: Abstract should consist of study methodology, results and conclusion in brief

A field experiment was conducted during Zaid 2022 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P) on the topic “Effect of varieties and gypsum on the growth and yield of groundnut (*Arachis hypogaea*)”, to study treatments consisting of Varieties viz. K-1812, K-6 and K-Amaravati and three levels of Gypsum viz. 200, 300, 400 kg/ha. The results revealed that treatment 3 (K-1812 (Lepakshi) + Gypsum (400 kg/ha) recorded significantly higher number of nodules/plant (52.00), higher dry weight (30.96 g), crop growth rate (30.63 g/m²/day), relative growth rate (0.0447 g/g/day), maximum number of pods/plant (39.93), maximum number of kernels/pod (2.0), Shelling percentage (72.4 %), Pod yield (3.67 t/ha), higher seed yield (2.72 t/ha), higher haulm yield (4.66 t/ha) and higher harvest index (31.55%), maximum gross return (1,54,260.00 INR/ha), maximum net return (1,04,999.00 INR/ha) and maximum benefit cost ratio (2.13).

Comment [MP2]: No need to mention the title in the abstract

Keywords: Varieties, Gypsum, Growth, Yield, Economics.

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is a leguminous plant that is widely cultivated in the tropics and subtropics. It is valued for its high-oil content and edible seeds. It is the fourth most important source of edible oil and a third most important source of vegetable protein in the world. Groundnut is not only an important oilseed crop of India but also an important agricultural export commodity (ANGRAU, 2021). It belongs to family Leguminaceae and is fourth most important source of edible oil and third most important source of vegetable protein also known as “The King of Oilseeds”. Globally 50% of groundnut is used for oil extraction, 37% confectionary and 12% seed purpose. According to Satish *et al.* (2011), groundnut is primarily used for extraction of oil, with an analysis of about 46.70%. It is also consumed directly because of its high food value, which is again due to its higher content of protein

(22.0%), carbohydrate (10.0%) and minerals(3.0%).

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Globally, Groundnut covers 315 lakh hectares with the production of 536 lakh tonnes with the productivity of 1701/ha (FAOSTAT, 2021). With annual all-season coverage of 55.71 lakh hectares, globally, India ranks first in Groundnut area under cultivation and is the second largest producer in the world with 102 lakh tonnes with productivity of 1831 kg/ha (GOI, 2021). In Uttar Pradesh during 2019-20 groundnut covered an area of 93822 hectares with the production of 88.371 lakh tonnes with the productivity of 940 kg/ha (DAC, 2021).

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Variety Kadiri 6 is released from the Agriculture Research Station, Kadiri Andhra Pradesh. Its parentage is JL24 x AH 316. It was released in the year 2002. The Crop duration 100-105 (kharif) 110-115 (rabi). Its average Yield in quintal/ha is 20-25 (kharif) 40-45 (rabi). The Oil percentage is 48% and shelling is 74%. 100 Kernel weight (g) is 35-40g. The salient features are early variety, high yielding, spanish bunch, attractive kernel, and synchronous maturity.

Variety Kadiri Amaravathi is released from the Agriculture Research Station, Kadiri Andhra Pradesh. Its parentage is Kadiri 6 x NCAc2242. It was released in the year 2016. The Crop duration 115-120 (kharif) 120-12 (rabi). Average Yield in quintal/ha is 20-25 (kharif) 40-45 (rabi). Oil percentage 50%. Shelling percentage 70%. 100 Kernel weight (g) 48g. The salient features are High yielding, medium duration, spanish bunch with attractive pods like kadiri-6. Resistant to sucking pests like thrips, hoppers, mite and leaf eating insects, spodoptera & helicoverpa, resistant to PSND & PBND.

Variety Kadiri Lepakshi (K 1812) is released from the Agriculture Research Station, Kadiri Andhra Pradesh. Its parentage is (ICGV 92069 / ICGV 93184) x ICGV 98300). The year of release 2020 The crop duration kharif (112). Average Yield in quintal/ha is 35 (kharif). The oil percentage 51%. Shelling percentage 70%. 100 Kernel weight (g) 40g. The salient features are Very high yielding, profuse bearing spanish variety with high oil and high protein. Multiple resistant to drought, pests and diseases. Stable yields (15-20 q/ha) even under severe drought.

The primary nutrients calcium and varieties also plays an important role in enhancing production and productivity of groundnut. Varieties is very crucial for the formation of varieties containing amino acids and oil synthesis and it also improves both yield and quality of crops.

Comment [MP5]: Check the grammar

They also effect the yield and quality of crops.

Calcium nutrition is also considered a yield limiting factor for groundnut production.

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Check the grammar everywhere

Calcium absorbed by the roots is not trans located to the developing pod whereas calcium required for pod formation is absorbed directly from soil solution (Yadav *et al.*, 2014). Groundnut plants need high level of calcium during pod filling stage to obtain better yield of quality kernels and its deficiency directs to unfilled pods (Reddy, 2006) Gypsum is readily available source of calcium as well as varieties for crops and varieties is necessary for improving the oil content in groundnut (Rao *et al.*, 2013) Application of gypsum improves soil structure which favours effective pegging in groundnut (Agasimani *et al.*, 1992). Varieties and calcium are applied together are considered to be very important in the pod zone for the developments of pegs (Geethalakshmi *et al.*, 1998).

Selection of improper variety leads to reduction in yields, reduction in the quality of the produce, attack of pests and diseases, environmental deformities if the variety does not suite the particular climate, soil borne diseases, genetic abnormalities and many other side effects at the time of crop production and also that might influence the next crop.

Similarly, due to sulphur deficiency in groundnut leaves turn pale; young as well as middle leaves show chlorosis; under severe conditions leaves become papery. As it is used in the formation of amino acids, proteins, and oils, the contents of plant protein and oil content in seeds, chlorophyll contents and also nodulations significantly decrease in the absence of sulphur.

The calcium deficiency also leads to restricted kernel development resulting in poor pod filling. Such pods are called as “pops”. Air fills the pods in the absence of proper kernel development.

Through this research right variety for groundnut crop production is aimed to be found among the selected varieties and also through correct dose of gypsum sulphur and calcium requirement is aimed to fulfil as sulphur is responsible for chlorophyll formation, promotes nodulation in legumes, helps develop and activate certain enzymes and vitamins, and is a structural component of two of the 21 amino acids that form protein, plays a vital role in the development of seed and improving oil quality. Calcium requirement can be fulfilled which is a very major nutrient in groundnut that helps in good filled pods, oil contents improvement, strong shell and overall quality of the crop. Along with that supplying sulphur and calcium through gypsum specially helps in fulfilling the nutrient requirement and also majorly in improving the soil structure which favours effective pegging in groundnut.

Comment [MP7]: Provide references for scientific statements

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Lengthy statement
Rewrite the sentence
Split the statement into 2-3 statements

MATERIALS AND METHODS

Study Area / Experimental site

A field experiment was conducted on the topic “Effect of varieties and gypsum on the growth and yield of groundnut (*Arachis hypogaea*)” during Zaid 2022 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P), India which is located at 25.40° N latitude, 81.85 ° E longitude, and 98 m altitude above the mean sea level (MSL). The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.1), low in organic carbon (0.28%), available N (225 kg/ha), available P (19.50 kg/ha) and available K (92 kg/ha). Nutrient sources were Urea, Single Super Phosphate, Murate of Potash and Gypsum to fulfil the requirement of Nitrogen, Phosphorus, Potassium, Calcium and Sulphur respectively respectively.

Comment [MP9]: Title of the study not required

Experimental design

The experiment was laid out in Randomized Block Design (RBD) with nine treatments replicated thrice. The treatments consisted Varieties viz. K-1812, K-6 and K-Amaravati and three levels of Gypsum viz. 200, 300, 400 kg/ha. The treatment combinations are T1-Kadiri-1812(Lepakshi) + Gypsum (200kg/ha), T2-Kadiri-1812 (Lepakshi) + Gypsum(300kg/ha), T3-Kadiri-1812 (Lepakshi) + Gypsum (400kg/ha), T4-Kadiri-6 + Gypsum (200kg/ha), T5-Kadiri-6 + Gypsum (300kg/ha), T6-Kadiri-6 + Gypsum (400kg/ha), T7- Kadiri Amaravati + Gypsum(200kg/ha), T8- Kadiri Amaravati + Gypsum (300kg/ha) and T9-Kadiri Amaravati + Gypsum (400kg/ha). RDF of 25:60:40 NPK kg/ha was used in all treatments as basal dose, also Gypsum was applied by the side of the plants on 45th day and it is incorporated into the soil by earthing up immediately. Seeds were dibbled manually at the seed rate of 100 kg/ha. The growth parameters and yield, production was recorded at harvest from randomly selected plants in each plot. These parameters were statistically analyzed using analysis of variance (ANOVA) as applicable to Randomized Block Design. The data was computed and analysed by following statistical method of Gomez and Gomez (1984).

Comment [MP10]: Provide the treatment design in the form of table also

RESULTS AND DISCUSSION

Comment [MP11]: Show the results in the form of graphs
Please provide graphs for all the treatments

Plant height (cm)

The significantly taller plant height (39.16 cm) at 60 DAS was recorded in treatment 3 with K-1812 (Lepakshi) + Gypsum (400 kg/ha). However, treatment 5 [Kadiri-6 + Gypsum (300 kg/ha)] was statistically at par with the treatment 6 [Kadiri-6 + Gypsum (400 kg/ha)] (Table 1).

Plant height increased with the increasing with dose of gypsum from 0 to 400 kg/ha (**Adhikari et al., 2003**). The increase in plant height might be due to the increased supply of sulphur through gypsum and associated nutrients might have helped in rapid cell multiplication and higher chlorophyll content, thereby accelerating photosynthesis rate in plants that in turn increase a canopy, plant height at the successive growth stages. These results are in agreement with the finding of **Ramya et al. (2022)**. Among the 3 varieties the highest plant height observed in Kadiri-6. The result was similar with the (**Sujathamma et al., 2022**). Among three growth habits erect type showed highest mean plant height (39.76cm) followed by Decumbent-2 growth habit (36.18cm), decumbent-3 (36.64cm). This was corroborated with (**priya et al., 2016**) they reported that K6 (erect) recorded highest Plant height (44.3cm).

Number of nodules per plant

The significantly higher number of nodules/plant (140.00) at 60 DAS were recorded with the treatment 3 with K-1812 (Lepakshi) + Gypsum (400 kg/ha). However, treatment 2 [K-1812 (Lepakshi) + Gypsum (300 kg/ha)] was statistically at par with the treatment 3 [K-1812 (Lepakshi) + Gypsum (400kg/ha)] (Table 1). Significant and Maximum number of nodules/plant observed with the application of gypsum might be due to plant feeds nutrients to the growing seed instead of the nodule during pod formation and filling, legume nodules lose their ability to fix nitrogen (**Ramya et al., (2022)**). another reason where nodules get sulphur addition through gypsum is a main responsible factor for root nodules formation and calcium created a congenial soil environment for root growth and nodules development (**Prabhu, 2019**).

Plant dry weight (g).

The significantly maximum dry weight (12.58 g) was recorded with treatment 3 with K-1812 (Lepakshi) + Gypsum (400 kg/ha). However, treatment 9 [K- Amaravathi + Gypsum (400 kg/ha)] was statistically at par with the treatment 3 [K-1812 (Lepakshi) + Gypsum (400 kg/ha)].

Significantly higher plant dry weight was with Kadiri Lepakshi may be due to production of branches/plant and increased assimilation of nutrients which increased the leaf biomass compared to other varieties similar results were reported by **Akram et al. (2021)**. further increase in dry weight might be due to the application of gypsum, which results in the highest growth of groundnut, highest growth of groundnut might be due to increased availability and

uptake of macro and micronutrients and improving soil conditions for water and nutrient supply required for better plant growth and dry matter accumulation (**Ramya et al., 2022**).

Crop growth rate (g/m²/day) and Relative growth rate (g/g/day)

Between 60-80 DAS Relative Growth Rate was recorded significantly highest (0.0447 g/g/day) in treatment 3 with K-1812 (Lepakshi) + Gypsum (400 kg/ha). However, treatment 9 [K- Amaravathi + Gypsum (400 kg/ha)], treatment 8 [K- Amaravathi + Gypsum (300 kg/ha)], treatment 7 [K- Amaravathi + Gypsum (200 kg/ha)], treatment 6 [K-6 + Gypsum (400 kg/ha)] and treatment 5 [K-6 + Gypsum (300 kg/ha)] were statistically at par with the treatment 3 [K- 1812 (Lepakshi) + Gypsum (400 kg/ha)](Table1).The significant and higher relative growth rate was observed with the application of gypsum (400kg/ha) which might be due to improved nutritional environment at cellular level and leaf chlorophyll content appears to have increased the photosynthetic rate. Thus, it is obvious that the improved growth and development of the plants and might be due to enhanced metabolic activities and photosynthetic rate resulting in improvement in the accumulation of dry matter at the successive growth stages further increase in the relative growth rate. Similar result were found with **Reddy et al. (2022)**.

Yield attributes

Number of pods per plant

Treatment 3 [(K-1812 (Lepakshi) + Gypsum (400 kg/ha)] was recorded significantly higher No. of pods per plant (39.93). However, treatments 2 [(K-1812 (Lepakshi) + Gypsum (300 kg/ha)] was statistically at par with the treatment 3 [(K-1812 (Lepakshi) + Gypsum (400 kg/ha)](Table2).Higher number of pods/plant was observed with the application of gypsum (400 kg/ha) might be due to its vital role in energy storage and transformation, carbohydrate metabolism and activation of enzymes also increase the photosynthetic activity of the plant. Similar results were reported by **Banu et al. (2017)**.

Number of kernels per pod

Treatment 3 [(K-1812 (Lepakshi) + Gypsum (400 kg/ha)] was recorded highest No. of kernels per pod (2.00), though there was no significant difference amongst the treatments.

Seed index(g)

Treatment 6 [Kadiri-6 + Gypsum (400 kg/ha)] recorded significantly highest Seed Index (40.33). However, treatment 5 [(K-6 + Gypsum (300 kg/ha))] was statistically at par with the treatment 6 [(K-6 + Gypsum (400 kg/ha))](Table2). This significant and higher seed index observed in Kadiri-6 might be due to the difference between the varieties originated from their genetic background (Sujathamma and Naik, 2022).

Shelling(%)

Treatment 3 [(K-1812 (Lepakshi) + Gypsum (400 kg/ha)] was recorded significantly higher shelling (72.40%). However, treatment 2 [(K-1812 (Lepakshi) + Gypsum (300 kg/ha)] was statistically at par with the treatment 3 [(K-1812 (Lepakshi) + Gypsum (400 kg/ha))](Table2). Significant and higher shelling percentage was recorded in K-1812 might be due to the difference between the varieties for the shelling percent originated from their genetic background (Sreelatha *et al.*, 2019). Further, increase in shelling percentage with the application of gypsum might be due to it appeared at early flowering reduces the number of empty pods similar results were reported by Adhikari *et al.* (2003).

YIELD

Pod yield(t/ha)

Treatment 3 [(K-1812 (Lepakshi) + Gypsum (400 kg/ha)] recorded significantly higher Pod Yield (3.60 t/ha). However, the treatment 2 [(K-1812 (Lepakshi) + Gypsum (300 kg/ha)] and treatment 1 [K-1812 (Lepakshi) + Gypsum (200 kg/ha)] were statistically at par with the treatment 3 [(K-1812 (Lepakshi) + Gypsum (400 kg/ha))](Table2). Significant and higher pod yield obtained in Kadiri Lepakshi (K-1812) might be due to its higher yielding potential up to (4.2 t/ha) compared to other varieties Akram *et al.* (2021). Further increase in pod yield with the application of gypsum might be due to the availability of Sulphur and calcium to crops during the grand growth phase lead to better growth and development of pods. Calcium plays a vital role in the reproductive development of the groundnut crop, the similar result was reported by Ramya *et al.* (2022).

Seed yield(t/ha)

Treatment 3 [(K-1812 (Lepakshi) + Gypsum (400 kg/ha)] was recorded significantly higher Seed Yield (2.61 t/ha). However, treatment 2 [(K-1812 (Lepakshi) + Gypsum (300 kg/ha)] was statistically at par with the treatment 3 [(K-1812 (Lepakshi) + Gypsum (400 kg/ha)](Table2).

Higher seed yield was observed in K-1812 might be growth attributes recorded significantly higher values compared to other varieties, due to high light interception avoidance of mutual shading and more dry matter accumulation per unit amount of light interception which results increase in seed yield. (Sreelatha *et al.*, 2019). Further, increase in seed yield with the application of Gypsum that provides Calcium and mobilization of Calcium from soil to the podingroundnutcroptakesplacethroughthegynophoressotheamountofcalciumtransported decides the seed yield. Calcium application reduces ovule abortion and enhanced pod development,thus,resultinginincreasedyields.TheresultsaesimilarwithBanuetal.(2022) and Naiknaware *etal.*(2015).

Haulm yield(t/ha)

Treatment 3 [(K-1812 (Lepakshi) + Gypsum (400 kg/ha)] was recorded significantly higher Halum Yield (4.66 t/ha). However, treatment 2 [(K-1812 (Lepakshi) + Gypsum (300 kg/ha)] was statistically at par with the treatment 3 [(K-1812 (Lepakshi) + Gypsum (400 kg/ha)](Table2). Higher haulm yield observed in K-1812 might be due to a greater number of plants/unit area,interaction between varieties and seed rates. Similar results were reported with **Sujathamma andNaik(2022)**.Furtherincreaseinhaulmyieldwiththeapplicationofgypsummightbedue to utilization of large quantities of nutrients through their well-developed root system and nodules which might have resulted in plant development and straw yield. Similar results were reported by **Mandal *et al.*(2005)**.

Harvest Index(%)

Treatment 3 [(K-1812 (Lepakshi) + Gypsum (400 kg/ha)] was recorded significantly higher Harvest Index (31.55%). However, treatment 2 [(K-1812 (Lepakshi) + Gypsum (300 kg/ha)] was statistically at par with the treatment 3 [(K-1812 (Lepakshi) + Gypsum (400 kg/ha)](Table2).Significant and higher harvest index observed with the application of Gypsum at 400 kg/ha might be due to better nutritional environment in the root zone for growth and development.It's vital role in several physiological and biochemical process which are ofvital importantee for the development of the plants. Similar results were reported by **Reddy *et al.*(2022)**.

ECONOMICS

Maximum gross return (1,54,260.00 INR/ha), maximum net return (1,04,999.00 INR/ha) and maximum benefit cost ratio (2.13) was recorded in treatment 3 [K-1812 (Lepakshi) + Gypsum (400 kg/ha)] as compared to other treatments (Table 3). Higher net returns, gross returns and benefit cost ratio was obtained with application of K-1812 (Lepakshi) might be due to higher pod and haulm yields. The better growth and yield attributes might have enhanced the pod and biological yield of groundnut. Similar result was reported by **Yadav *et al.* (2018)**.

UNDER PEER REVIEW

Table 1. Effect of Varieties and Gypsum levels on growth parameters of groundnut.

S No.	Treatments	60 DAS			60 DAS- 80 DAS	
		Plant Height (cm)	Number of Nodules/ Plant	Dry weight (g)	Crop Growth Rate (g/m ² /day)	Relative Growth Rate (g/g/day)
1.	K-1812 (Lepakshi) + Gypsum at 200 kg/ha	19.80	126.00	12.11	22.48	0.0374
2.	K-1812 (Lepakshi) + Gypsum at 300 kg/ha	20.40	138.00	12.26	23.57	0.0384
3.	K-1812 (Lepakshi) + Gypsum at 400 kg/ha	22.60	140.00	12.58	30.63	0.0447
4.	K-6 + Gypsum at 200 kg/ha	35.80	94.27	11.43	21.15	0.0374
5.	K-6 + Gypsum at 300 kg/ha	38.65	102.00	11.03	23.10	0.0407
6.	K-6 + Gypsum at 400 kg/ha	39.16	110.00	11.23	23.70	0.0409
7.	K-Amaravati + Gypsum at 200 kg/ha	18.60	118.00	11.98	26.15	0.0419
8.	K-Amaravati + Gypsum at 300 kg/ha	20.10	122.00	12.06	27.23	0.0428
9.	K-Amaravati + Gypsum at 400 kg/ha	21.60	128.00	12.45	29.65	0.0444
	F-test	S	S	S	NS	S
	Sem±	0.31	0.72	0.05	1.49	0.0014
	CD at 5%	0.94	2.17	0.15	4.47	0.0042

Table 2. Effect of Varieties and Gypsum levels on yield attributes and yield of groundnut.

S No.	Treatments	No. of pods/ plant	No. of Kernels/Pod	Seed Index(g)	Shelling (%)	Pod yield (t/ha)	Seed yield (t/ha)	Haulm Yield (t/ha)	Harvest Index (%)
1.	K-1812 (Lepakshi) + Gypsum at 200 kg/ha	37.00	1.93	38.12	71.60	3.51	2.52	4.57	31.10
2.	K-1812 (Lepakshi) + Gypsum at 300 kg/ha	38.00	2.00	38.21	72.00	3.59	2.59	4.62	31.50
3.	K-1812 (Lepakshi) + Gypsum at 400 kg/ha	39.93	2.00	39.41	72.40	3.67	2.72	4.66	31.55
4.	K-6 + Gypsum at 200 kg/ha	22.00	1.73	39.46	70.60	3.08	2.18	4.14	30.11
5.	K-6 + Gypsum at 300 kg/ha	24.00	1.87	39.88	70.40	3.16	2.22	4.22	30.14
6.	K-6 + Gypsum at 400 kg/ha	25.00	1.93	40.33	71.20	3.24	2.31	4.30	30.59
7.	K-Amaravati + Gypsum at 200 kg/ha	25.67	1.93	36.05	69.46	3.07	2.13	4.13	29.62
8.	K-Amaravati + Gypsum at 300 kg/ha	28.00	1.93	37.10	69.40	3.10	2.15	4.16	29.63
9.	K-Amaravati + Gypsum at 400 kg/ha	30.00	1.87	37.56	68.40	3.12	2.14	4.18	29.23
	F- test	S	NS	S	S	S	S	S	S
	Sem±	0.83	0.07	0.17	0.17	0.02	0.04	0.01	0.11
	CD at 5%	2.47	--	0.50	0.52	0.18	0.16	0.04	0.32

Table 3. Effect of Economics of groundnut as influenced by Varieties and Gypsum.

S No	Treatments	Total cost of cultivation	Gross Returns	Net Returns	B:C ratio
1	K-1812 (Lepakshi) + Gypsum at 200 kg/ha	47261.00	143170.00	95909.00	2.03
2	K-1812 (Lepakshi) + Gypsum at 300 kg/ha	48261.00	147070.00	98809.00	2.05
3	K-1812 (Lepakshi) + Gypsum at 400 kg/ha	49261.00	154260.00	104999.00	2.13
4	K-6 + Gypsum at 200 kg/ha	46261.00	124040.00	77779.00	1.68
5	K-6 + Gypsum at 300 kg/ha	47261.00	126320.00	79059.00	1.67
6	K-6 + Gypsum at 400 kg/ha	48261.00	131350.00	83089.00	1.72
7	K-Amaravati + Gypsum at 200 kg/ha	45261.00	121280.00	76019.00	1.68
8	K-Amaravati + Gypsum at 300 kg/ha	46261.00	122410.00	76149.00	1.65
9	K-Amaravati + Gypsum at 400 kg/ha	47261.00	121880.00	74619.00	1.58

CONCLUSION

Based on ~~this my~~ research trail, the treatment combination with the variety K-1812(Lepakshi) along with application of Gypsum at (400kg/ha) was found to be more productive and economical. Although the findings are based on one season further research is needed to confirm the findings and their recommendation.

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