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Optimizing calcium nutrition for yield and quality improvement in peanut (*Arachis hypogea*)

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Abstract

Peanut (*Arachis hypogea* L.) is a vital legume crop valued for its nutritional and economic significance, particularly in developing countries. Calcium (Ca) plays a crucial role in peanut pod development, yet comparative research on different calcium sources under uniform agronomic conditions remains limited. This study aimed to evaluate the effects of various calcium fertilizers—gypsum, dolomitic limestone, nano calcium, zeolite, and calcium nitrate—on the growth, yield, calcium content, and oil content of peanut. Conducted under a controlled experimental setup using a Completely Randomized Design (CRD), the study assessed parameters such as pod number, pod weight, seed weight, shelling percentage, calcium and oil content. Results showed that treatments with dolomitic limestone and calcium nitrate significantly enhanced pod and seed weights, reduced the number of pop pods, and resulted in the highest dry yields, with calcium nitrate achieving an 81.63% yield advantage over the control. Gypsum treatment yielded the highest seed calcium content (79 mg), while oil content remained relatively unaffected across all treatments. Although shelling percentage and 100-seed weight did not differ significantly, calcium application, particularly through calcium nitrate and dolomitic limestone, demonstrated strong potential for improving peanut yield and seed quality. The findings support the inclusion of these calcium sources in integrated soil fertility strategies for sustainable peanut production.

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Introduction

Peanut (*Arachis hypogea* L.) locally known as "mani" belongs to family Fabaceae. It is one of the most important cash legume crops cultivated mainly for its edible seeds. It is the thirteen most important food crop and the third major oilseed crop in the world. It has high protein content which ranges from 22-30% of its total calories, making peanut a great source of plant-based protein. It also contains high amount of minerals, antioxidants and vitamins such as riboflavin, niacin, vitamin B-6 and folates. It is utilized worldwide for its nutrition, protein and energy-rich to address the nutritional needs in developing countries. Currently, it is considered as good heart-healthy diet and value in phytonutrient such as resveratrol, isoflavonoids, phenolic acids, and phytosterols, which may enhance health and wellness.

Peanuts are a legume containing a vigorous root system and good scavenger of many nutrients, calcium is an important secondary macronutrient after nitrogen, phosphorus and potassium for the proper development of the plant. It is typically important for the formation of cell walls, cell members and accumulates in the plant cells (Kadirimangalam *et al.*, 2022).

Lack of absorption of calcium into the peanut hull in the pegging zone can result in pops (no full kernels inside the pods), reducing yield. Calcium deficiency of peanuts can also encourage or lead to pod rot diseases. Calcium is routinely applied as lime, and applied at pegging, for rapid replenishment of available calcium. Adequate calcium in the pegging zone is essential for proper peanut development because this is where developing pods obtains calcium. Pods must acquire calcium from the surrounding soil due to lack of xylem flow into the peg and immobility of calcium in the phloem. Lack of xylem flow into the peg is attributed to the lack of transpiration once it is underground. Calcium enters the seed by diffusing directly from soil into the hull, where it is channeled to the funiculus. This is the only point where the developing seed is physiologically attached to the surrounding hull. From the funiculus, the calcium is delivered to the seed.

Inadequate and imbalance use of nutrient, poor soil health and drought stress, high levels of aflatoxin contamination in harvested kernels are the common problem worldwide in peanut production (Njoroge *et al.*, 2017).

The effectiveness of calcium application was expected to provide baseline information for the development of a sustainable and tailored regional and national. In spite of the strong economic pressure on agricultural production, many farmers are making the transition to practices that have the potential to contribute to long-term agricultural sustainability on peanut production. Therefore, to solve the pressing needs in nutrient management in peanut production, calcium application on the productivity of peanut is considered to be very promising nutrient management. Although calcium is a well-known essential nutrient for the growth and development of peanut, especially for pod formation and seed quality, there is still a significant research gap regarding the application of different calcium fertilizers. Most existing studies focus on single sources such as gypsum, with limited comparative analysis of various calcium fertilizers like calcium nitrate, calcium chloride, and organic calcium sources under the same agronomic conditions. This lack of comprehensive comparison makes it difficult to determine the most effective and economical calcium source for different soil types and climatic conditions. Furthermore, limited attention has been given to the timing and method of calcium application, which can significantly influence nutrient uptake and pod filling. The interaction between calcium fertilizers and soil properties such as pH, texture, and organic matter content—also remains underexplored, despite their known effects on calcium availability and mobility. Additionally, while yield improvement is often emphasized, the impact of different calcium sources on pod quality, seed composition, and overall crop marketability is not well-documented. Another critical but overlooked aspect is the influence of calcium fertilizers on soil microbial activity and root health, which are essential for sustainable nutrient cycling. Long-term studies evaluating the environmental and agronomic implications of repeated calcium fertilizer use are also scarce. Addressing these gaps would provide a more complete understanding of how different calcium fertilizers can be optimized to improve both yield and quality in peanut production systems.

The application of different calcium fertilizers in peanut cultivation can contribute meaningfully to several United Nations Sustainable Development Goals (SDGs), particularly those focused on food security, sustainable agriculture, and environmental protection. Primarily, this practice supports Zero Hunger by enhancing peanut yield and quality through improved nutrient management, which can lead to increased food availability and better nutritional outcomes, especially in regions where peanuts are a staple crop. Proper calcium nutrition is critical for pod development and seed filling, directly influencing productivity and contributing to more stable food systems. Furthermore, adopting efficient and appropriate calcium fertilizers aligns with Responsible Consumption and Production, as it encourages the use of targeted inputs that minimize nutrient waste and environmental degradation. By choosing calcium sources that are compatible with local soil and climate conditions, farmers can reduce the risk of soil nutrient imbalances and improve resource use efficiency. The application of sustainable calcium fertilizer strategies also contributes to SDG Climate Action, as it promotes soil health and resilience, potentially reducing the need for excessive fertilizer inputs and lowering greenhouse gas emissions associated with fertilizer production and use. Additionally, optimizing calcium use in peanut farming can support Life on Land by preserving soil structure and preventing nutrient runoff, which helps maintain land productivity and biodiversity. Finally, integrating research-based and site-specific calcium fertilization practices into peanut cultivation can contribute to Partnerships for the Goals, by fostering collaboration between researchers, farmers, and policymakers to develop sustainable agricultural systems. Overall, the careful and informed application of different calcium fertilizers in peanut production not only boosts agricultural productivity but also promotes environmental sustainability and long-term food security. The study was conducted to evaluate the response of peanut to different calcium fertilizer specifically on the growth, yield, calcium and oil content of peanut.

Materials and methods

Procurement of seeds

Peanut seeds (BPI Pn 9 variety) were procured from the Cagayan Valley Research Center, City of Ilagan, at least one month prior to the start of the experiment.

Soil sampling and analysis

Soil samples were collected both before land preparation and after harvest. Samples were air-dried, pulverized, and cleared of inert materials. A one-kilogram composite soil sample was submitted to the DA-CVIAL Regional Soil Laboratory in Tuguegarao City, Cagayan, for analysis. The results, particularly the levels of nitrogen (N), phosphorus (P), potassium (K), and soil pH, served as the basis for treatment formulation.

Preparation of soil media and experimental layout and design

A total of 360 polyethylene bags (10 × 10 × 20 inches) were prepared, with 20 bags per treatment. Each bag was filled with 10 kilograms of dried soil collected from a previously cultivated vegetable area in Sanchez Mira, Cagayan. The treatments were arranged in a Completely Randomized Design (CRD) with three replications, each consisting of 20 bags per treatment.

Experimental treatments

The treatments used in the study are the following:

Treatment 1 - 20-10-30 kg NPK per hectare

Treatment 2 - Gypsum

Treatment 3 - Dolomitic Limestone

Treatment 4 - Nano Calcium

Treatment 5 - Zeolite

Treatment 6 - Calcium Nitrate

Application of fertilizers

A blanket application of inorganic fertilizer (20-10-30 kg NPK per hectare), based on soil test results, was applied at planting.

Planting and thinning

Three peanut seeds were manually sown per bag. Replanting was done one week after emergence if necessary. Thinning was conducted afterward, leaving two healthy plants per bag.

Application of different calcium fertilizers

Calcium fertilizers were applied 40 days after planting at a rate equivalent to 200 kilograms per hectare, adjusted according to the soil volume per bag. Application was localized in the pegging zone, approximately 3 to 4 inches away from the plant base.

Pest management

Pest and disease outbreaks were controlled promptly using insecticides and manual methods, as needed.

Irrigation

Watering was conducted based on plant requirements and environmental conditions.

Harvesting

Plants were harvested manually once the leaves began to yellow and when the pods were nearly filled.

Threshing

Harvested pods were stripped immediately. Care was taken during picking to prevent detachment of the peduncle along with the pod.

Drying

After threshing, the peanuts were sun-dried until they reached a moisture content of approximately 14%.

Shelling

The dried groundnuts were carefully shelled to prevent damage such as scratching, splitting, rupturing of the seed coat, or breaking of the cotyledons.

Sorting

After shelling, peanuts were manually cleaned and sorted into categories: rejects, broken nuts, whole nuts, and unshelled nuts. Traditional methods such as winnowing using a bamboo tray ("bilao") and manual hand-picking were employed. Substandard kernels and foreign materials (e.g., moldy, broken, or discolored seeds) were separated from the good kernels.

Calcium and oil content assessment

A one-kilogram seed sample from each treatment was submitted to SGS Philippines, Inc. in Makati City for analysis of calcium and oil content.

Statistical analysis and design

Data were analyzed using Analysis of Variance (ANOVA) under the Completely Randomized Design (CRD) framework, utilizing the Statistical Tool for Agricultural Research (STAR) software. Treatments showing significant differences were further analyzed using Tukey's Honestly Significant Difference (HSD) test.

Result and discussion

Total number of pods

The total number of pods per plant among the different treatments did not vary significantly, indicating that calcium fertilizer had no substantial impact on the number of pods developed (Table 1).

Table 1. Total number of pods per plant as affected by different source of calcium fertilizer

Treatments	Total number of pods
T_1 – 20-10-30 kg NPK ha-1	176.93
T_2 – Gypsum	181.97
T_3 – Dolomitic Limestone	178.67
T_4 – Nano Calcium	178.40
T_5 – Zeolite	179.27
T_6 – Calcium Nitrate	181.50
Result	ns
C.V. (%)	4.18

The application of pure inorganic fertilizer or inorganic fertilizer plus calcium regardless of source produced pods ranging from 176.93 to 181.97. Despite the application of fertilizer from recommended rate based on soil analysis and combination of inorganic fertilizer and calcium fertilizer which is known to influence plant health and growth; however, the results suggest that calcium did not play a direct role in enhancing pod production in this case.

Number of good pods

Statistical analysis of the data on the total number of pods per peanut plant reveals significant differences among the treatments (Table 2), Treatment 3 (Dolomitic Limestone) and T_6 (Calcium Nitrate) achieved the highest mean pod counts, 168.00 and 169.50 respectively, signifying that their effects were statistically superior to the other treatments. Although they did not vary to T_2 (Gypsum), T_4 (Nano Calcium) and T_5 (Zeolite) indicating that it was significantly less effective than T_3 and T_6 with mean values ranging from 148.40 to 154.30, meaning their performance was not significantly different from each other and yet comparable to T_1 (20-10-30 kg NPK ha^{-1}) with 126.90. These results demonstrate that calcium fertilization, particularly through dolomitic limestone and calcium nitrate, significantly enhances pod production in peanuts, while the omission of calcium in T_1 resulted in notably lower yields. Recent studies have consistently demonstrated that calcium supplementation significantly enhances peanut pod production, underscoring its critical role in reproductive development. A study by Wang *et al.* (2023) found that applying of calcium fertilizer increased pod yields by 11.5% to 29.6% compared to treatments without calcium. This improvement was attributed to enhanced net photosynthetic rates and better nutrient accumulation in the kernels, which are vital for pod development. Similarly, research by El-Sayed *et al.* (2023) highlighted that soil-applied calcium significantly boosted pod yields across various peanut cultivars achieved a 57.79% increase in pod yield when treated with soil calcium. This was linked to improved pod and seed development, as well as enhanced oil content, emphasizing the importance of calcium in both quantity and quality of peanut production. These findings align with earlier research indicating that calcium is essential for pod formation and development in peanuts. Adequate calcium levels facilitate proper peg penetration and pod filling, leading to increased pod numbers and improved seed quality.

Table 2. Number of good pods per plant as affected by different source of calcium fertilizer

Treatments	Number of good pods
T_1 – 20-10-30 kg NPK ha-1	126.90b
T_2 – Gypsum	153.60ab
T_3 – Dolomitic Limestone	168.00a
T_4 – Nano Calcium	148.40ab
T_5 – Zeolite	154.30ab
T_6 – Calcium Nitrate	169.50a
Result	**
C.V., (%)	6.14
HSD	33.18

Note: Means with common letter are not significantly different with each other using Honestly Significant Different test, ** - significant at 1% level

Number of pop pods

Table 3 presents the number of pop pods in peanut as affected by application of from different sources of calcium fertilizer. Statistical interpretation of the data on the number of pop pods per plant shows significant variation among treatments. T_1 with a mean of 50.00 pop pods, was significantly higher than all other treatments, indicating it had the greatest occurrence of pop pods (pods that form but do not fully develop seeds). Followed by T_4 (30.00) which did not vary to T_2 (28.33), T_5 (25.00) and T_6 (12.00). The least was achieved in T_3 (10.67) suggesting significantly fewer pop pods and therefore better pod filling and development. These results suggest that while T_1 led to the highest number of pop pods, likely due to calcium deficiency or imbalance affecting seed set, treatments like T_3 (Dolomitic Limestone) and T_6 (Calcium Nitrate) were more effective in reducing the number of unfilled pods, contributing to improved pod quality and reproductive success in peanuts. Recent studies have highlighted the effectiveness of calcium applications, particularly through Dolomitic Limestone and Calcium Nitrate, in enhancing peanut pod development and reducing the occurrence of unfilled pods. A study by Wang *et al.* (2023) demonstrated that applying 568 kg ha^{-1} of calcium fertilizer increased pod yields by 11.5% to 29.6% compared to treatments without calcium. This improvement was attributed to enhanced net photosynthetic rates and better nutrient accumulation in the kernels, which are vital for pod development. Unfilled peanut pods, often referred to as "pop pods," can significantly reduce yield and quality. Wang *et al.* (2023). Stated that several factors contribute to this issue, including environmental stress and nutrient imbalances. Calcium deficiency is a primary cause of unfilled pods. Calcium plays a crucial role in cell wall stability and peg penetration, essential for pod development. Inadequate calcium uptake, leads to poor pod formation.

Table 3. Number of pop pods per plant as affected by different source of calcium fertilizer

Treatments	Number of pop pods
T_1 – 20-10-30 kg NPK ha^{-1}	50.00a
T_2 – Gypsum	28.33bc
T_3 – Dolomitic Limestone	10.67c
T_4 – Nano Calcium	30.00b
T_5 – Zeolite	25.00bc
T_6 – Calcium Nitrate	12.00bc
Result	**
C.V. (%)	20.75
HSD	19.01

Note: Means with common letter are not significantly different with each other using Honestly Significant Different test, ** - significant at 1% level

Fresh weight of good pods (g)

The statistical interpretation of the data on total pod weight per plant clearly shows significant differences among the treatments (Table 4). T_3 (Dolomitic Limestone) recorded the highest total pod weight at 237.17 grams per plant, indicating it was significantly superior to the other treatments. This was closely followed by T6 (Calcium Nitrate) with 226.33 grams, T_2 (Gypsum), T_4 (Nano Calcium), and T_5 (Zeolite)- produced moderate yields ranging from 172.04 to 178.63 grams and yet were comparable to T_1 - (20-10-30 kg NPK ha^{-1}) with a total fresh pod weight at 116.85 grams. The results strongly suggest that calcium application, particularly in the form of Dolomitic Limestone and Calcium Nitrate, plays a critical role in maximizing pod weight in peanuts. This is consistent with recent findings by Mohamed *et al.* (2023) examined the effects of calcium fertilization on various peanut cultivars under clay soil conditions, peg development, and seed formation. The significant yield difference between calcium-treated and untreated plots emphasizes the necessity of including calcium in fertilization strategies for optimal peanut production.

Table 4. Fresh weight of good pods (g) per plant as affected by different source of calcium fertilizer

Treatments	Fresh weight (g)
T_1 – 20-10-30 kg NPK ha^{-1}	116.85c
T_2 – Gypsum	172.04bc
T_3 – Dolomitic Limestone	237.17a
T_4 – Nano Calcium	178.27abc
T_5 – Zeolite	178.63abc
T_6 – Calcium Nitrate	226.33ab
Result	**
C.V. (%)	9.89
HSD	64.37

Dry weight of good pods (g)

Table 5 shows the dry weight of good pods as affected by different sources of calcium fertilizer. The data on the weight of dry pods reveals statistically significant differences among the treatments applied. Treatment 6 (Calcium Nitrate) and T_3 (Dolomitic Limestone) produced the heaviest pods, with values of 181.63 grams and 174.00 grams, respectively. Indicating that their means are not significantly different from each other but are significantly higher than those of all other treatments. Treatments T_2 (Gypsum), T_4 (Nano Calcium), and T_5 (Zeolite) yielded moderate pod weights of 128.93, 134.07, and 138.83 grams, respectively. This implies that these three treatments are statistically similar in their effects, providing better results than the lowest-performing treatment but not as effective as the top-performing ones. The lowest pod weight was observed in T_1, the standard NPK fertilizer (20-10-30 kg/ha), at 87.90 grams. This indicates that T_1 performance was significantly lower than all other treatments. Overall, the data suggest that calcium-based soil amendments, particularly Calcium Nitrate and Dolomitic Limestone, significantly enhance dry pod yield compared to recommended rate of NPK fertilization and other alternative treatments. Calcium (Ca) application has been shown to significantly enhance pod development in various legume crops, including peanuts, by improving photosynthetic efficiency, nutrient distribution, and overall plant health. A study by Cao *et al.* (2023) demonstrated that applying 150 kg/hm² of calcium oxide (CaO) to peanuts increased dry matter accumulation in leaves, pegs, kernels, and shells, leading to a 10.5% higher pod yield compared to untreated controls. This improvement was attributed to enhanced transport of photosynthetic carbon to the kernels during the pod bulking stage. In peanuts, calcium application has also been associated with improved nutrient uptake and distribution. These findings underscore the importance of calcium in supporting pod development and enhancing yield in legume crops. Appropriate calcium fertilization can improve photosynthetic efficiency, nutrient distribution, and overall plant health, leading to increased pod production and crop productivity.

Table 5. Dry weight of good pods (g) per plant as affected by different source of calcium fertilizer

Treatments	Dry weight (g)
T_1 – 20-10-30 kg NPK ha^{-1}	87.90c
T_2 – Gypsum	128.93b
T_3 – Dolomitic Limestone	174.00a
T_4 – Nano Calcium	134.07b
T_5 – Zeolite	138.83b
T_6 – Calcium Nitrate	181.63a
Result	**
C.V. (%)	4.92
HSD	19.93

Note: Means with common letter are not significantly different with each other using Honestly Significant Different test, ** - significant at 1% level

Seed weight (g)

The data on seed weight indicates statistically significant differences among the six treatments applied (Table 6). Treatment 6 (Calcium Nitrate) and T_3 (Dolomitic Limestone) recorded the heaviest seeds, with values of 133.93 grams and 130.47 grams, respectively. These treatments suggesting that they are not significantly different from one another but are significantly superior to the other treatments. Treatments T_2 (Gypsum), T_4 (Nano Calcium), and T_5 (Zeolite) yielded seed weights of 98.53, 98.87, and 98.23 grams, respectively. This indicates that while these treatments do not significantly differ from each other, they result in significantly higher seed weights than the control treatment but lower than the calcium-rich T_3 and T_6 treatments. The control, T_1 (20-10-30 kg NPK ha^{-1}), recorded the lowest seed weight at 59.67 grams, highlighting its significantly poorer performance compared to all other treatments. Overall, the statistical analysis supports the conclusion that calcium-based treatments, particularly Dolomitic Limestone and Calcium Nitrate, are most effective in increasing seed weight, while standard NPK application without supplemental calcium is the least effective. Recent studies have consistently demonstrated that calcium (Ca) application significantly enhances seed weight in peanuts (*Arachis hypogea*), underscoring its critical role in promoting pod development and overall yield. Calcium is essential for various physiological processes in plants, including cell wall stability, nutrient transport, and photosynthesis, all of which contribute to improved seed development (Wang *et al.*, 2023).

Table 6. Seed weight (g) per plant as affected by different source of calcium fertilizer

Treatments	Seed weight (g)
T_1 – 20-10-30 kg NPK ha^{-1}	59.67c
T_2 – Gypsum	98.53b
T_3 – Dolomitic Limestone	130.47a
T_4 – Nano Calcium	98.87b
T_5 – Zeolite	98.23b
T_6 – Calcium Nitrate	133.93a
Result	**
C.V. (%)	5.52
HSD	20.07

Note: Means with common letter are not significantly different with each other using Honestly Significant Different test, ** - significant at 1% level

Shelling percentage (%)

The shelling percentage data indicates that there were no statistically significant differences among the treatments, despite observable numerical variations. Treatment values ranged from 67.88% to 76.42%. These differences were not large enough to be considered statistically significant, suggesting that none of the calcium or soil amendments had a consistent or strong enough effect on shelling percentage to surpass the variability in the data. This implies that, under the conditions of this study, shelling percentage remained relatively stable regardless of the nutrient treatment applied. It may also indicate that shelling percentage is less responsive to calcium supplementation compared to traits like pod or seed weight, and may be influenced more by genetic or environmental factors than by soil nutrient amendments (Table 7).

Table 7. Shelling percentage (%) (g) as affected by different source of calcium fertilizer

Treatments	Shelling percentage
T_1 – 20-10-30 kg NPK ha⁻¹	67.88
T_2 – Gypsum	76.42
T_3 – Dolomitic Limestone	74.98
T_4 – Nano Calcium	73.74
T_5 – Zeolite	70.76
T_6 – Calcium Nitrate	73.74
Result	ns
C.V. (%)	8.00

Weight of 100 seeds (g)

Table 8, shows the effect of different calcium application on the weight of 100 seeds. The data revealed that all calcium sources, including gypsum, dolomitic limestone, nano calcium, zeolite, and calcium nitrate, resulted in statistically similar 100-seed weights in peanuts, indicating no significant differences among these treatments. Although numerical differences were observed, with 100-seed weights ranging from 46.67g to 54.00g across calcium-treated plots. This suggests that while calcium plays a vital role in improving overall yield components that also influence on individual seed size as measured by the 100-seed weight may be limited or less responsive to the specific calcium form used. Similar findings were reported by El-Gabry *et al.* (2023), who noted that different calcium sources, including nano-calcium and calcium nitrate, improved overall seed yield in peanuts but did not significantly affect 100-seed weight when compared across treatments. These results highlight that while calcium is essential for plant development, not all yield traits are equally sensitive to the form of calcium.

Table 8. Weight of 100 seeds (g) as affected by different source of calcium fertilizer

Treatments	Seed weight (g)
T_1 – 20-10-30 kg NPK ha⁻¹	32.33b
T_2 – Gypsum	46.67a
T_3 – Dolomitic Limestone	54.00a
T_4 – Nano Calcium	46.67a
T_5 – Zeolite	53.33a
T_6 – Calcium Nitrate	53.33a
Result	**
C.V. (%)	5.46
HSD	9.17

Note: Means with common letter are not significantly different with each other using Honestly Significant Different test, ** - significant at 1% level

Yield advantage

The yield advantage of calcium application in peanut is presented in Table 9. The data on yield advantage from different calcium treatments clearly demonstrate the positive impact of calcium on plant growth, as measured by dry weight per plant. All calcium-enriched treatments showed substantial improvements. The application of calcium nitrate (T_6) resulted in the highest yield advantage at 81.63%, with a dry weight of 181.63 g per plant, indicating its superior effectiveness in enhancing plant biomass. Dolomitic limestone (T3) followed closely with a 74.00% yield advantage, suggesting its strong contribution through both calcium and magnesium supplementation. Zeolite (T_5) and nano calcium (T_4) also provided considerable improvements with yield advantages of 38.83% and 34.07%, respectively, highlighting their potential as effective soil amendments. Gypsum (T_2), while showing a lower increase compared to others, still provided a 28.93% yield advantage, validating its role as a useful calcium source. Overall, the data confirm that calcium application significantly boosts plant growth, with calcium nitrate emerging as the most effective treatment among those tested.

Table 9. Yield advantage on the use of calcium fertilizer (%)

Treatments	Dry weight (g) per plant	Yield advantage (%)
T_1 – 20-10-30 kg NPK ha⁻¹	87.90	-
T_2 – Gypsum	128.93	28.93
T_3 – Dolomitic Limestone	174.00	74.00
T_4 – Nano Calcium	134.07	34.07
T_5 – Zeolite	138.83	38.83
T_6 – Calcium Nitrate	181.63	81.63

Calcium and oil content

The soil content and calcium content of peanut seeds as affected by different source of calcium is presented in Table 10. The data presented on the oil content of peanuts under different treatments suggests that the application of various calcium sources and amendments had a relatively similar effect on the oil content. Among the treatments, the highest oil content was observed in T_2 (Gypsum), with 47.05 grams, closely followed by T_1 (20-10-30 kg NPK ha-¹), which recorded 46.86 grams of oil. Calcium nitrate (T_6) also showed a high oil content of 46.77 grams, indicating that the addition of calcium in the form of nitrate does not significantly reduce oil production in peanuts. On the other hand, treatments involving Dolomitic limestone (T_3), Nano Calcium (T_4), and Zeolite (T_5) had slightly lower oil content, with values of 44.83 grams, 43.54 grams, and 44.12 grams, respectively. This suggests that while calcium plays a role in enhancing plant growth, the form in which it is applied (whether as gypsum, calcium nitrate, or dolomitic limestone) may not drastically alter the oil content of peanuts. The results also imply that, within the scope of these treatments, calcium application does not significantly influence oil yield, with values remaining fairly consistent across most treatments. Therefore, while calcium is important for overall plant health and growth, its direct effect on the oil content of peanuts appears to be minimal or inconclusive in this specific experiment.

Table 10. Oil and calcium content of peanut seeds as affected by different source of calcium fertilizer

Treatments	Oil (g)	Calcium (mg)
T_1 – 20-10-30 kg NPK ha^{-1}	46.86	63.46
T_2 – Gypsum	47.05	79.00
T_3 – Dolomitic Limestone	44.83	68.54
T_4 – Nano Calcium	43.54	65.07
T_5 – Zeolite	44.12	71.46
T_6 – Calcium Nitrate	46.77	73.60

In terms of the calcium content of peanut seeds, the data on the calcium content of peanut seeds under different treatments reveals that calcium application had a noticeable impact on the calcium levels in the seeds. The highest calcium content was observed in T_2 (Gypsum), with 79 mg of calcium per seed, indicating that the gypsum treatment provided the most significant boost in calcium uptake. This is likely due to the high solubility of gypsum, which makes calcium readily available for absorption by the plant. Calcium nitrate (T_6) also showed a relatively high calcium content of 73.60 mg, suggesting that the nitrate form of calcium effectively contributed to increased calcium levels in the seeds. Other treatments, such as Zeolite (T_5) and Dolomitic Limestone (T_3), also resulted in elevated calcium content, with values of 71.46 mg and 68.54 mg, respectively, demonstrating that these calcium sources contributed to higher calcium uptake compared to the control treatment. Nano Calcium (T_4) produced a slightly lower calcium content of 65.07 mg, which could be due to the form in which calcium was applied, possibly limiting its availability or uptake by the plant. Meanwhile, the control treatment, T_1 (20-10-30 kg NPK ha^{-1}), showed the lowest calcium content in the seeds at 63.46 mg, indicating that the standard NPK fertilizer alone did not provide sufficient calcium for optimal seed development. Overall, these results suggest that calcium application, especially in the form of gypsum and calcium nitrate, significantly increases the calcium content in peanut seeds, which is crucial for improving seed quality and plant health.

Conclusion

In conclusion, the overall effect of calcium on peanut development was notably positive, particularly in enhancing number of good pods, pod weight, seed weight and weight of 100 seeds, which are critical yield components. Calcium-based treatments such as Dolomitic Limestone and Calcium Nitrate consistently produced the highest values for dry pod and seed weights, significantly outperforming the control and other treatments. While parameters such as total number of pods per plant and shelling percentage showed no statistically significant differences among treatments. The data collectively demonstrate that calcium supplementation, particularly in readily available forms like calcium nitrate or soil-conditioning forms like dolomitic limestone, can effectively enhance peanut productivity, making it a valuable agronomic input for improving yield performance. Highest yield advantage was obtained in the application of Calcium Nitrate by 81.61 percent. The application of calcium, across various forms such as gypsum, calcium nitrate, dolomitic limestone, nano calcium, and zeolite, had minimal impact on the oil content of peanut seeds in this experiment. Moreover, the application of calcium through gypsum showing the highest in calcium level content of peanut seeds.

Recommendation

Based on the findings, it is recommended to use dolomitic limestone and calcium nitrate as part of a balanced soil fertility management program in peanut production. Calcium Nitrate obtained 81.61% yield advantage while application of gypsum is recommended to increase the calcium content of peanut seeds and to improve seed nutritional quality.

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