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Analysis of N, P, K in Land on Nuts Land (*Arachis hypogaea* L.) In Immature Oil Palm Plantation

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Abstract

Peanuts (*Arachis hypogaea* L.) are legumes that can improve soil fertility through nitrogen fixation by Rhizobium bacteria. Research on changes in soil nutrient content—specifically nitrogen (N), phosphorus (P), and potassium (K), before and after peanut planting, as well as root responses in coconut palm oil land, is important for establishing effective land management strategies. This study aims to determine the changes in nutrient content (N, P, and K) of land before and after planting peanuts as an intercrop in TBM land (land not yet producing) for coconut oil palm. The research was conducted at People's Garden Hill Bahorok Gate, Langkat Regency, from May 2025 to February 2026, using descriptive statistics. The researchers planted five beds with a total of 1,000 Gajah peanut seeds. The entire cultivation process was performed manually without the use of fertilizers, pesticides, fungicides, insecticides, or mulch, to assess the plant's natural ability to enhance soil nutrients. The results showed a peanut yield of 8.8 kg over three months, with 748 live plants. Soil analysis before planting indicated N content of 0.07%, P of 19.78 ppm, and K of 0.06 me/100 g. After planting, nutrient levels increased to N 0.08%, P 48.47 ppm, and K 0.19 me/100 g. The increase in nitrogen was influenced by the activity of Rhizobium bacteria. In contrast, the increases in phosphorus and potassium likely originated from the decomposition of organic matter and plant residues. This study shows that peanuts can increase soil fertility in oil palm TBM land while providing economic benefits for farmers.

Keywords: Nutrients NPK, Peanut soil, Plant between, Plants Not Yet Producing (TBM), Rhizobium

1. Introduction

Peanuts (*Arachis hypogaea* L.) are a food crop with significant economic value, serving as a source of food, animal feed, and raw materials for various industries. Peanuts are widely used in processed foods and are rich in protein, fat, iron, and vitamins (Sianpiar et al., 2020). Peanut seeds contain approximately 40–48% oil, 25% protein, 18% carbohydrate, and vitamin B complex (Mendrofa et al., 2025). According to the Indonesian Central Statistics Agency (BPS RI, 2020), peanut production in Indonesia in 2018 was 512,198 tons, with the Bangka Belitung Islands Province producing 201 tons. This figure remains relatively low and has decreased compared to production in previous years. To meet Indonesia's needs, high demand for peanuts must be balanced with increased production. Efforts to boost peanut production can be carried out through land intensification, expanding planting areas, and increasing productivity per unit of land.

Expanding planting areas can be achieved by using peanuts as intercrops in rows of oil palms in non-productive oil palm plantations. Based on Indonesian Plantation Statistics Data, the area of oil palm plantations in Bangka Belitung Islands Province that are not yet producing (TBM) is 23,630 hectares. Using oil palm land for peanut cultivation offers opportunities, given that coconut plantations in these areas are still widespread and largely unproductive. Increasing peanut productivity through intercropping in oil palm plantations that are not yet producing can be supported by the application of organic fertilizer derived from oil palm waste, which will help optimize land use and enhance agricultural productivity during this period. During the utilization of oil palm land as an intercrop, it is recommended to limit the intercropping period to only 2 years (TBM 2), as this aligns with the period when oil palm plants begin to enter an intensive growth phase (Lestari, 2022).

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Improving productivity in oil palm plantations can be achieved through rejuvenation, as some Indonesian oil palm plantations are over 25 years old, with low productivity (less than 13 tons of fresh fruit bunches per hectare per year), and are no longer profitable. The government has also provided grant assistance for the Oil Palm Rejuvenation Program (PSR), with subsidies ranging from Rp 25 million to Rp 30 million per hectare. This subsidy is expected to encourage farmers to be more enthusiastic about rejuvenating their unproductive crops. However, farmers' income may decrease during the rejuvenation period (TBM), as their income largely depends on fresh fruit bunch (FFB) production.

One alternative for farmers to generate income during this period is to plant non-oil palm crops using an overlapping system or intercropping on empty land (gawangan) in TBM. Crops such as rice, corn, and soybeans are commonly used as alternative intercrops in this system. Peanuts and soybeans have potential as intercrops in land undergoing oil palm rejuvenation because they form symbiotic relationships with bacteria that fix nitrogen, converting it into a form available to plants. Peanuts, in particular, grow well at temperatures of 25–30°C and are resistant to drought and dry weather conditions, making them a suitable crop during dry seasons. (Muin et al., 2023).

Utilization of intercropping of peanuts on TBM land for oil palm is currently more focused on increasing farmer income and land use efficiency. At the same time, information regarding changes in chemical properties is still needed, especially nutrient content: nitrogen (N), phosphorus (P), And potassium

(K) as a result of planting peanuts limited (Muin et al., 2023).

In fact, peanuts, as a legume, can form a symbiosis

with nitrogen-fixing bacteria, which can improve soil fertility and support the growth of oil palm. Oil palm in the TBM phase. In addition, plants compete for nutrients and root growth space. gap with coconut palm oil is also an important concern in sustainable intercropping systems. Therefore, research on changes in the content of N, P, and soil K before and after planting peanuts and the response of oil palm roots to the presence of peanut beds is important to carry out as a basis for land management. TBM is more effective, productive, and sustainable (Lithourgidis et al., 2011).

This research aims to find out what changes have occurred. on the elements N, P, and K that are present in the soil before and after planting peanut intercrops, or rather the decrease in soil nutrient content, and how the TBM oil palm roots respond to peanut beds. land.

2. Material and Methods

The study was implemented in Jl. Bukit Lawang, Sampe Raya, Bohorok District, Langkat Regency, North Sumatra. The research was conducted from May 2025 to February 2026. The study used a qualitative descriptive method by describing and comparing the results of laboratory analyses of each sample. obtained.

The materials used were a hoe, a rake, a watering can, a measuring tape, and a hand sprayer. The tools used were 1,000 peanut seeds of the early-maturing variety. The Gajah peanut seeds have the main advantages of being highly adaptable to drought and resistant to drought. They also have potential for high yields. This variety produces jumbo-sized seeds with red skins, making it a superior choice for agricultural productivity. Peanuts were planted between oil palm plants using raised beds. Five beds were used in this study. Each bed had 100 planting holes. Each hole planted 2 peanut seeds.

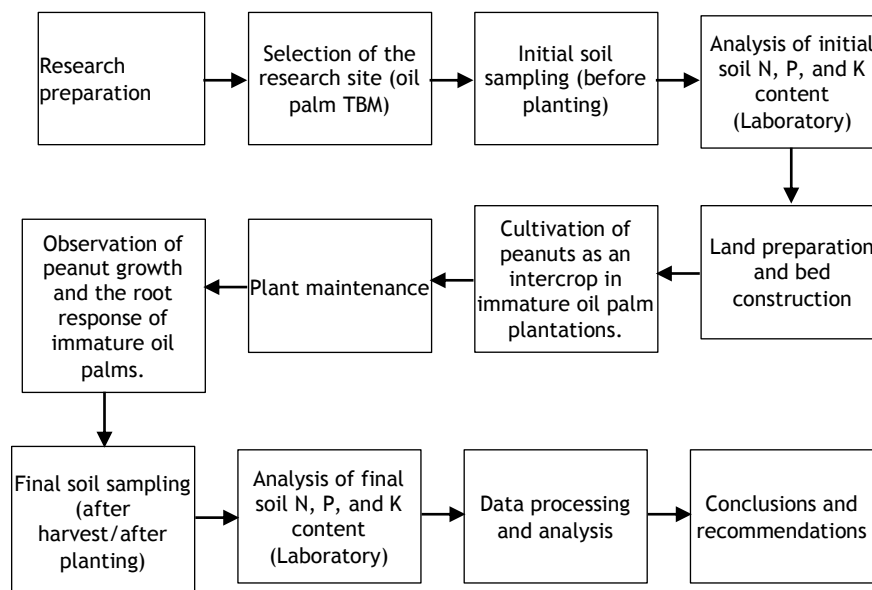


Figure 1. Channel implementation study

Soil sampling was carried out by first determining the location to be used as research beds. After determining the location, the center point of each bed was used as a reference for sampling. Soil samples are taken by hoeing the ends. We sampled the middle and the other end of each bed in all research beds. All soil samples obtained were then mixed on a tarp until homogeneous. After being mixed evenly, the soil samples were divided into four parts, then the top right and bottom left ends were discarded, while the bottom left end on And

The bottom right corner is mixed again. This process is repeated until approximately 1 kg of soil sample is obtained. The obtained soil sample is then taken to the laboratory. For the analyzed element content (Hara N, P, and K), land preparation before planting is carried out (Saragih et al., 2023).

3. Results and Discussion

Intercropping in the TBM (Immature Plants) phase of oil palm is an intercropping cultivation technique to optimize the use of available land, so that areas that have not yet been planted can be used. Areas covered by the oil palm canopy are not overgrown with weeds but are planted with plants that are economically and ecologically beneficial. Farmers in the village apply intercropping systems on TBM oil palm plantations because they can improve the financial performance of farming businesses. According to Lumbanraja et al. (2025), intercropping on oil palm plantations plays a role in optimizing empty areas of land between plants in coconut oil palm. One intercrop that can be used is peanuts because they have root nodules that contain Rhizobium bacteria. These play a role in the fixation of nitrogen (N) from the air.

Although nitrogen is abundant in the atmosphere, the form of nitrogen that plants can directly use is limited, which reduces growth efficiency. To increase nitrogen availability in the soil, one effective solution is the use of nitrogen-fixing bacteria, such as Rhizobium, which are capable of binding free nitrogen from the atmosphere and converting it into a form that is easily absorbed by plants (Veres et al., 2026). Rhizobium bacteria play an important role in soil ecosystems because they form symbioses with legume plants to carry out nitrogen fixation. This process converts atmospheric nitrogen into compounds that plants can use, such as ammonium (NH_4^+), thereby contributing to increased soil fertility and plant productivity. According to Sari and Retno (2015), Rhizobium can carry out effective nitrogen fixation only when residing within the root nodules of its host plants.

The efficiency of use of Rhizobium bacteria can be maximized without causing harm or environmental pollution. Furthermore, its utilization is relatively inexpensive and uses simple technology. Fahrni (2018) stated that the use of peanuts as an intercrop is also

considered better than LCC (*Legume Cover Crop*) because the peanut yield is edible and has nutritional value. Which tall. Peanut land rich

will vitamin E, which functioning as an antioxidant for skin and heart health, and contain various B complex vitamins, especially niacin (B3), folate (B9), thiamine (B1), And Vitamin B6. In addition to vitamins, peanuts also contain high levels of protein, healthy fats, fiber, and minerals such as magnesium. and potassium.

The quantity and quality of peanut production can be improved of applying appropriate cultivation technologies. Intensive peanut cultivation techniques include the use of high-quality seeds, which are a key requirement for cultivation, characterized by clean, pest- and disease-free, and uniform seeds. Furthermore, successful cultivation is also influenced by optimal land preparation, planting, and plant maintenance.

3.1. Peanut Crop Production

Peanuts are a legume commodity with unique ecophysiological characteristics, namely the ability to increase soil fertility through a symbiotic atmospheric nitrogen fixation mechanism with Rhizobium bacteria in root nodules (Marwan et al., 2019). In the context of oil palm Immature Plant (TBM) land utilization, the success of peanut production is strongly influenced by soil physicochemical conditions, nutrient availability, and the effectiveness of applied cultivation techniques.

In this study, peanut planting was carried out on land that had undergone soil cultivation and raised beds. All cultivation activities were carried out manually, without the use of tools. mechanical. In addition, this study did not involve the provision of additional fertilizers, pesticide use, or mulch. The absence of fertilizer in this study aims to describe the natural condition of soil fertility and to determine the ability of peanut plants to increase soil nutrient content, especially nitrogen (N), phosphorus (P), and potassium (K), without any influence from external inputs. The absence of pesticide use is intended to avoid the impact of chemicals on the activity of soil microorganisms that play a role in biological processes, especially nitrogen fixation. Meanwhile, the lack of mulch allows for direct soil monitoring without additional treatments that could affect soil moisture and temperature.

In implementation research, some plants grow well, while others die. Suitable environmental conditions—such as sufficient water availability, good soil structure, and adequate nutrient content—generally support optimal plant growth. Additionally, the presence of Rhizobium bacteria in plant roots plays a role in helping supply nitrogen to the plants (Waruwu et al., 2025). Plant mortality is thought to be influenced by several factors, including limited water availability, low soil nutrient content, and unfavorable environmental conditions. Pest or disease attacks may also contribute, particularly due to a lack of pesticide control.

Other factors, such as low seed germination, can also affect early plant growth and overall outcomes.

Under these conditions, the production results obtained are expected to reflect the natural capabilities of the land in providing nutrients and demonstrating the role of peanut

plants in improving soil fertility in oil palm plantations. Based on research conducted over three months of planting, peanut production was 8.8 kg. The peanut production data are summarized in the following table.

Table 1. Data on growth and crop production on each bed.

Bed	Number of Seeds/ Bed	Number of Holes/Beds	Number of Plants that are Living/Hole	Number of Plants that Dead/Hole	Flat Branch/ Bed Average	Production
1	200	100	132	68	4	1.7 kg
2	200	100	136	64	4	0.9 kg
3	200	100	148	52	4	1.6 kg
4	200	100	164	36	4	2, 5 kg
5	200	100	168	32	5	2kg
total	1000	500	748	252	4	8.7 kg

Plants that are not growing well are primarily affected by the lack of fertilizer, fungicides, and insecticides. No mulch is used, and weeds are controlled manually with a scraper. Additionally, many seed plants are attacked by fungi due to high soil humidity, causing the seeds to rot. Furthermore, termites eat many seeds. We did not use fertilizers, mulch, insecticides, or fungicides to observe peanut growth results solely from their natural ability to fix nutrients, without external assistance. This approach aims to evaluate the innate nutrient-fixing capacity of the peanut plants. NPK nutrients for soil planted with peanuts.



Figure 2. Comparison results: plants per bed

3.2. N, P, K Content of Soil Before Planting Intercrops

The analysis results show that the nitrogen (N) content in the soil was 0.07%, which is considered low. This low nitrogen level indicates that the soil has limited capacity to support vegetative plant growth, particularly in leaf development and chlorophyll formation. Low nitrogen is

generally caused by low organic matter content and the washing away of soil nutrients. This condition is an important reason for using symbiotic plants with Rhizobium bacteria (Zega et al., 2025).

Table 2. Analysis results: N and P content, and K before planting peanut land.

No Lab	No Sort	On Base Heavy Dry 105°		
		N (%)	P (ppm)	K (m. e/100g)
2478 /25	1	0.07	19.78	0.06

Source: PPKS, 2026.

The available phosphorus (P) content in the soil is 19.78 ppm, which is classified as moderate. Phosphorus plays a vital role in root system development, flowering, and seed formation. Phosphorus levels in the moderate range indicate that the soil is still capable of supporting plant growth, although its availability can be affected by soil pH conditions and fixation by aluminum (Al) and iron (Fe), especially in acidic soils (Maharani, 2025).

Meanwhile, the potassium content is 0.06 cmo 1/kg, which falls in the low category. Potassium plays a role in increasing plant resistance to environmental stress, strengthening plant tissues, and aiding the translocation of photosynthesis products. Low potassium levels indicate that the soil requires special attention in nutrient management due to potassium deficiency. can inhibit plant growth and production (Maharani, 2025). Initial soil conditions before planting peanuts indicate that nitrogen and potassium are the main limiting factors, while phosphorus is sufficient. Therefore, planting peanuts as an intercrop is expected to increase soil fertility, especially of adding nitrogen. biological.

3.3. N, P, K content of soil After Planting Interval

of analyzed element content in soil nutrients after planting peanuts to evaluate changes in soil properties. The land is on TBM (Immature Plants) oil palm land. TBM land generally maintains a stable level of fertility, so the presence of intercrops such as peanuts is expected to improve soil conditions of contributing organic matter and

increasing biological activity in the soil (Lumbanraja et al., 2025). Results of soil samples after planting peanuts are as follows.

Table 3. Results of N, P, and K content analysis after planting peanuts.

No Lab	No Sort	Dry Weight Base 105°		
		Total (%)	PBrayII (ppm)	K (me/100g)
442 /26	1	0.08	48.47	0.19

Source: PPKS, 2026.

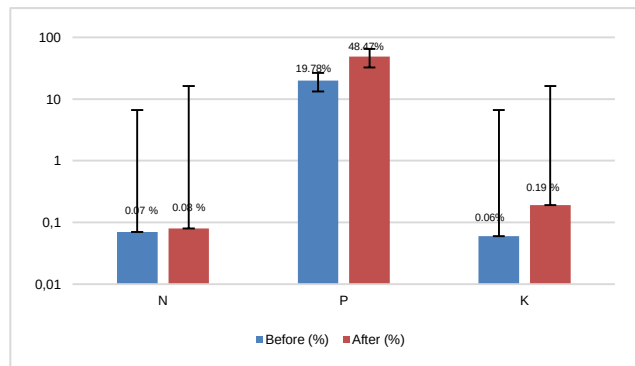


Figure 3. Comparison of nutrient elements before and after planting peanuts

The analysis showed that total soil nitrogen (N) increased by 0.01%, from 0.07% to 0.08%, after planting the intercrops, although it remained classified as low. Compared to pre-planting conditions, there was a slight increase in nitrogen content. This is because *Rhizobium* bacteria in peanut root nodules fix nitrogen from the air into the soil, indicating that peanut plants can indeed enhance soil nutrient levels. According to Francisca et al. (2023), *Rhizobium* inoculation can increase the number of root nodules, which directly contributes to improved nitrogen fixation.

The phosphorus (P) content after planting increased by 28.69% from 19.78% before planting the intercrops to 48.47%, a significant increase compared with the initial level, and is in the high category. This increase indicates that decaying organic matter in peanut soil can help increase P in the soil. According to Suharto et al. (2018),

organic materials can

The availability of phosphorus (P) increased as microbes converted the organic form in the fertilizer into an inorganic form with the help of microbes during decomposition. This produces soluble organic compounds, which facilitate the release of P that is fixed by calcium, making P available for plant absorption. Meanwhile, potassium (K) also experienced an increase of 0.13%, rising from a pre-planting value of 0.06% to 0.19%. On coconut TBM land with oil palm, this improvement in potassium levels can be attributed to the weathering of soil minerals, the release of potassium from the adsorption complex, and contributions from plant residues or organic materials beginning to decompose (Lumbanraja et al., 2020). Potassium plays a crucial role in enhancing water use efficiency, strengthening plant tissues, and increasing resistance to environmental stresses (Fahri et al., 2023).

4. Conclusion

Based on the research findings, planting peanuts as an intercrop on TBM oil palm land can provide benefits in increasing soil fertility. The analysis shows an increase in nutrient content—namely nitrogen (N), phosphorus (P), and potassium (K)—after planting peanuts. Nitrogen increased from 0.07% to 0.08%, phosphorus from 19.78 ppm to 48.47 ppm, and potassium from 0.06 me/100 g to 0.19 me/100 g. The rise in nitrogen is attributed to the activity of *Rhizobium* bacteria in peanut root nodules, which are capable of fixing atmospheric nitrogen. The increases in phosphorus and potassium are thought to result from the decomposition of organic materials and plant residues. During the study, peanut production reached 8.8 kg with a total of 748 plants from an initial planting of 1,000 seeds. Although some plants died due to environmental factors, low nutrient levels, high soil moisture, and the absence of fertilizers, pesticides, fungicides, and mulch, the results still indicate that peanuts can be an effective intercrop. They can improve soil fertility while providing economic benefits on TBM land for oil palm cultivation, supporting sustainable and natural agricultural practices.

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