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Calcium and Magnesium Fertilization upon Growth and Yield of Peanut (Arachis Hypogaea L.) in Inceptisol Soil

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Abstract- This study aims to determine the application of Calcium and Magnesium Fertilization and its Interaction upon the growth and yields of peanut (*Arachis hypogaea* L.) on *Inceptisol* soil. Statistical analysts use a Completely Randomized Design (CRD) consisting of two factors, namely Calcium and Magnesium fertilizer, each of which consisted of Calcium (Ca) fertilizer at a dose: Ca0: without administration of Captant, Ca1: 100 kg Captivity ha^{-1} = 0, 4167 grams Kaptan pot^{-1} and Ca2: 200 kg Kaptan ha^{-1} = 0.8333 grams pot^{-1} further Magnesium (Mg) fertilizer at a dose of Mg0: without Kieserite administration, Mg1: 75 kg Kieserite ha^{-1} = 0.3125-gram Kieserite pot^{-1} and Mg2: 150 kg Kieserite pot^{-1} = 0.625 Kieserite pot^{-1}. These two fertilizer dosage levels are combined into 9 treatments and make 3 replications thus in total there are 27 treatment units, and using polynomial regression to determine the relationship between the treatment and the dry weight of the seeds. The results show that fertilization of Calcium and Magnesium affects the growth and yields of peanut plants while the interaction has no significant effect. The optimal Ca fertilization is obtained at 159 kg ha^{-1} with a maximum dry weight yield of 28.48 g of plant^{-1} and optimal Mg fertilization of 81 kg ha^{-1} with a maximum dry weight of 32.06 g of plant^{-1}.

Keywords*- Peanuts, Inceptisol, Calcium, Magnesium*

I. INTRODUCTION

Peanut (*Arachis hypogaea* L.) plant is one of the important food-producing plants and has a high economic value, but peanut production in Indonesia is still low, which is below 1.0 ton ha^{-1}, although its potential can reach more than 4 tons ha^{-1} [1]. Given the low yields, while the market demand for peanuts for the industry is very large, it is necessary to make serious efforts to increase the yields. In the West Lombok area of West Nusa Tenggara, many peanut plants are cultivated in *inceptisol* soil.

Alkali washing such as Ca, Mg, and K often happens in *inceptisol* soil in wet tropical regions. In addition, the soil factor is easy to wash due to the high rainfall which causes many alkalies to disappear [2] and later [3] notes that the chemical properties of *inceptisol* soil such as relatively low pH, C-Organic, N, P, low K and the types of *inceptisol* soil in Lombok are mostly in areas with high rainfall. Ma'shum (1993) further states that *inceptisol* soils in Lombok have a rough texture with high nutrient reserves but have a low actual nutrient content with low soil fertility in the category of N, P, low S, and medium K with moderate acidity (6.5-6.8). Further, [4] says that peanut production in NTB especially in Lombok Island is still relatively low, reaching only 1.15 tons per hectare through technology packages involving N, P, and K fertilizers without Ca and Mg. To overcome the problem mentioned above, it is necessary to fertilize Ca and Mg to promote growth and yield of peanut (*Arachis hypogaea* L.) in *inceptisol* soil.

II. FORMULATION OF THE PROBLEM

Based on the description above, the problem is formulated as follows: Calcium and Magnesium fertilization affect growth and yield of peanut (*Arachis hypogaea* L.) in *inceptisol* soil.

III. RESEARCH PURPOSE

The purpose of this study is to determine: Fertilization of Calcium and Magnesium and their effect upon the growth and yield of peanut (*Arachis hypogaea* L.) plants in *inceptisol* soil.

IV. RESEARCH METHOD

This research is conducted at the Greenhouse of the Faculty of Agriculture, University 45 of Mataram from March 1st to June 30th in the year 2019. The process starts with preparing the land until harvesting the crops. The materials used include seeds of Bima variety peanut, Kaptan fertilizer ($CaCO_3$), Kieserite fertilizer ($MgSO_4.H_2O$), Furadan, Topsin, and Decis.

Statistical analysis uses a Completely Randomized Design (CRD) consisting of two factors; the first factor is the administration of Calcium fertilizer and the second factor is the administration of Magnesium fertilizer, each with the following dosage: Calcium Fertilizer (Ca) at a dose: Ca0: without Kaptan, Ca1: 100 kg Kaptan ha^{-1} = 0.4167 grams Kaptan pot^{-1} and Ca2: 200 kg Kaptan ha^{-1} = 0.8333 grams pot^{-1} further Magnesium (Mg) fertilizer at a dose of Mg0: without administration of Kieserite, Mg1: 75 kg Kieserite ha^{-1} = 0.3125 grams Kieserite pot^{-1} and Mg2: 150 kg Kieserite ha^{-1} = 0.625 Kieserite pot^{-1}. These two doses of fertilizer are combined into 9 treatments and 3 replications are made so that in total there are 27 treatment units. The data which has been analyzed statistically, if there are differences, a BNJ test will be conducted, each at a level of 5%. Data that has been analyzed statistically, if there are differences, a BNJ test will be performed, each at a level of 5%. Furthermore, polynomial regression will be used to determine the correlation between fertilizer and dry weight of seeds.

The process before planting the Bima variety peanut seeds is the preparation of a planting place in the greenhouse of the Faculty of Agriculture, University 45 of Mataram. Treatment of seeds before planting into the soil is by soaking it in water for 4 hours and then soaking it with a fungicide solution for 15 minutes. The soil as a medium is first air-dried for one month then sifted, then weighed each pot as much as 10 kg then filled with Calcium Carbonate ($CaCO_3$) and Kieserite ($MgSO_4.H_2O$) fertilizer according to treatment, then labeled according to treatment. The process when planting involves planting peanut seeds as much as 2 seeds per pot at a depth of 3-4 cm which will be maintained one plant per pot.

Planting will be followed by maintenance, parameter observation, and harvest. Maintenance includes watering, weeding, controlling pests and diseases using Topsin and Decis as much as 1 cc l^{-1}. The day before planting is given Furadan as much as 5 g each pot. Soaking is done when the plants have begun to flower. Observation parameters include plant height, number of leaves, number of pods contained, leaf dry weight, and seed dry weight. Furthermore, the harvest is done when the plant is 95 days old with the characteristics of brownish pods, hard, full of seeds, and thin skin.

V. RESULT AND DISCUSSION

The observational data are analyzed statistically to determine the effect of Calcium and Magnesium fertilizing upon the growth and yield of peanut plants which can be seen in the following table:

TABLE I. OBSERVATION RESULTS FROM STATISTICAL ANALYSIS GROWTH PARAMETERS AND YIELDS OF PEANUT (*ARACHIS HYPOGAEA* L.).

No	Parameters	Calcium	Magnesium	Interaction
1.	Plant Height 30 DAP (cm)	NS	NS	NS
2.	Plant Height 60 DAP (cm)	NS	NS	NS
3.	Number of Leaves Age 30 DAP (stem)	NS	NS	NS
4.	Number of Leaves Age 60 DAP (stem)	S	NS	NS
5.	Leaf Dry Weight (g $plant^{-1}$)	S	S	NS
6.	Number of Contained Pods (plant $pods^{-1}$)	S	S	NS
7.	Number of Empty Pods (plant $pods^{-1}$)	S	NS	NS
8.	Seed Dry Weight (plant $pods^{-1}$)	S	S	NS

NS: Not significant effect ($p \geq 0.05$)
S: Significantly influential ($p < 0.05$)
DAP: days after planting

Calcium fertilization shows an influence on the number of leaves at 60 DAP ($p < 0.05$) while the number of leaves at 30 DAP, plant height at 30 DAP, and plant height at 60 DAP had no significant effect ($p \geq 0.05$). Furthermore, Magnesium fertilization has a significant effect ($p < 0.05$) on leaf dry weight, the number of filled pods, and seed dry weight, while on growth parameters such as plant height, the number of leaves, and the number of empty pods have no effect ($p \geq 0.05$). The average values of these parameters are presented in table 2.

TABLE II. EFFECTS OF GIVING CALCIUM AND MAGNESIUM ON AVERAGE DRY WEIGHT OF LEAVES, NUMBER OF CONTAINED PODS, EMPTY PODS, AND SEED DRY WEIGHT.

Treatment	Number of Plant Leaves after 60 DAP	Number of Contain Pods	Number of Empty Pods	Dry Weight of Leaves (g $plant^{-1}$)	Seed Dry Weight (g $plant^{-1}$)
Ca0	23,00 b	29,00 b	2,89 a	6,19 b	21,44 b
Ca1	26,37 a	37,67 a	1,44 b	9,15 a	27,51 a
Ca2	24,31 ab	38,55 a	1,00 b	7,23 a	28,01 a
BNJ 5%	2,39	2,09	1,12	2,87	3,16
Mg0	23,79 a	34,22 b	1,78 a	8,25 b	25,50 b
Mg1	24,88 a	39,44 a	1,33 a	9,87 a	30,42 a
Mg2	25,01 a	31,55 c	2,22 a	7,38 b	20,76 c
BNJ 5%	2,39	2,09	1,12	2,87	3,16

Note: the number followed by the same letter, in the column, from the same treatment is not significantly different in the 5% BNJ test.

A. *Calcium Fertilizing (Ca)*

Based on the data in Tables 1 and 2 above, the results prove that Ca has a significant effect on the dry weight of seeds supported by the number of leaves at the age of 60 days, number of filled pods, number of empty pods, and leaf dry weight.

The data and results above show that the addition of Calcium can increase Ca ions which are absorbed by the Peanut plant. Calcium that is absorbed is then allocated to the roots and top of the plant, the leaves to form calcium pectate in the lamella of the cell wall that regulates the Physico-chemical processes in the plant body. According to [5] calcium and potassium play a role in regulating the physical-chemical processes in the plant body. Calcium ions cause dehydration, which affects household water plants that are antagonistic to Potassium ions and are important in the formation of leaf buds.

Calcium given can increase the number of plant leaves at the age of 60 HST. This shows that the calcium ions absorbed by peanut plants affect the vegetative formation of plants at growing points such as leaf bud growth and root tips to stimulate the number of leaves in plants that are 60 days old. According to [6] calcium adds an average of 0.5% to plant body growth, which is widely present in leaves, and in some plants these ions settle as Ca-oxalates in cells as constituents of vegetative components, because Ca ions are stable in the plant body. Increasing the number of leaves in plants that are 60 days old, this Vegetative growth is able to function to use the sun's energy to its maximum potential to produce carbohydrates that are then allocated in storage such as pods and seeds.

The results of this study indicate that fertilizing calcium at a dose of 100 kg ha-1 gives a significant increase in yield on the parameters of the number of pods and dry weight of seeds, as well as reducing the number of empty pods to the lowest position. This shows that Calcium ions play an important role in pod formation and soil reaction, with the addition of Ca there will be a process of suppression of the soil reaction (pH). According to Hanafiah (2017) the reaction occurs as follows:

$$CaCO3 \longrightarrow CaO + CO2$$

$$CaO + H2O \longrightarrow Ca(OH)2 \longrightarrow Ca2+ + 2OH-$$

In this reaction Calcium ions are increasingly absorbed by plants and the hydroxyl ions (OH-) produced will neutralize hydrogen ions (H +) produced by plant root respiration with reactions such as follows:

$$C6H12O6 + O2 \longrightarrow 6CO2 + 6H2O + E$$

$$6CO2 + 6\,H2O \longrightarrow 6\,H2CO3 \longrightarrow 6HCO3- + 6H+$$

By releasing H2CO3- and H+ ions from root respiration to the ground, the hydrogen (H+) ion plays an active role in the process of ion exchange with hydroxyl ions (OH-) in the soil so that the reaction becomes neutral as follows: where OH- + H+ → H2O (neutral) or does not affect the reaction of the soil or the pH of the soil remains in its original position, which is moderate (measurement pH = 6.6) so that the absorption of Ca ions increases with Ca giving of 100 kg ha-1. The dominant Ca absorption occurs in the formation of pods and seeds, which results in lower soil pH at harvest compared to the beginning of planting because many Ca ions are absorbed by the peanut plant and then allocated to the storage section such as pods and seeds so that the formation of pods and seeds is better and increased compared to Ca0 controls (0 kg Ca ha-1). According to [7] states that applying Calcium-containing fertilizers to peanut plants can produce heavier pods and seeds because Calcium acts as a compiler of the middle lamella in the cell wall and the development of growing points on the roots and leaf buds. Furthermore, [8] states that Ca is an important nutrient for the formation of peanut pods; therefore it requires the availability of Ca in a sufficient number of categories. The dry weight of seeds obtained increases quadratically as follows: Y = 21.44 + 8.855X - 2.785 X2 (R = 0.99), so that optimal Ca fertilization is obtained 159 kg ha-1 and the maximum dry weight yield of seeds is 28.48 g plant-1. Increasing the dose of Ca fertilizer above the optimal dose is the dominance of the influence of excessive Ca suppressing potassium with antagonistic properties [9].

B. Magnesium Fertilizing (Mg)

Magnesium application (Tables 1 and 2) above shows a significant effect on the dry weight of the seeds followed by the number of pods contained and the dry weight of the leaves. This shows that the addition of Magnesium can increase Mg uptake by Peanut plants. Magnesium which is absorbed by peanut plants is allocated to the top of the plant i.e. leaves to form Chlorophyll. According to [10] in one Chloropil unit there is one Mg atom such as chlorophyll A which is dark green ($C_{55}H_{72}O_5N_4Mg$) and chlorophyll B which is light green ($C_{55}H_{70}O_6N_4Mg$). The application of Mg in fertilization strongly supports the formation of more and heavier leaves in this study. Magnesium fertilization of 75 kg ha^{-1} produces the highest dry weight of the seed supported by the dry weight of the leaves and the number of leaves also tends to be highest. This happens because the number of leaves increases, thus affecting the wider leaf area so that the ability of the leaves to intercept solar energy more in the process of photosynthesis. The process of photosynthesis is high, the increased leaf dry weight parameter results in more photosynthetic (seed) yields. According to [11] states that the high index of leaf area causes high interception of sunlight per unit area where the process of photosynthesis takes place, then followed by greater accumulation of photosynthate in seed form so that the dry weight of seeds obtained increases quadratically as shown below: $Y = 25.5 + 0.162\,X - 0.001X^2$; (R = 0.99), and the maximum yield was 32.06 g of plant^{-1} with an optimal dose of Mg or Kieserite ($MgSO_4.H_2O$) fertilizer of 81 kg ha^{-1}. Increasing the dose of Kieserit fertilizer above the optimal dose is the effect of excessive Mg accelerating protein synthesis so that respiration increases and production decreases [12].

Interaction of Ca with Mg shows no significant effect on all parameters observed, this shows that the treatment of the dose level given in each treatment is not obtained with the right dose balance to work together to support plant growth and yield, in this condition the Ca and Mg elements are the antagonist is thus unable to support the growth and yield of peanut plants. According to [9] in Inseptisol soils containing high Mg, fertilized by Dolomite, manure, and KCl it is found that the Ca, Mg, and K nutrients are antagonistic. Furthermore, [13] states that Ca, Mg, K, and Na elements are antagonistic to their absorption if one element is more dominant thus resulting other elements will be disturbed. [14] stress more specifically that excess Mg creates antagonistic properties of the element Potassium so that potassium absorption decreases which results in disruption of plant growth and reduced yields.

VI. CONCLUSION

Calcium and Magnesium fertilization affect the growth and yield of Peanut plants while the interaction does not show a real effect. Optimal Ca fertilization at m159 kg ha^{-1} with maximum dry weight yield of 28.48 g plant^{-1} and optimal Mg fertilization at 81 kg ha-1 with maximum dry weight yield of 32.06 g plant^{-1}.

VII. SUGGESTION

In connection with this research carried out in the Greenhouse, it is necessary to try to be done in the open field at various seasons. Regarding the application of calcium and magnesium fertilization which refers to the optimal dosage to be something useful, it can be recommended to farmers.

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