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Absorption P of Soybean Plants (*Glycine max* L.(Merr)) in Cambisol Soil After Lime and Phosphate Fertilizer Application

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Abstract: Lime and fertilization are the right way to increase nutrients to increase P uptake of soybean plants (*Glycine max* L. (Merr)) on cambisol soil. This is done by paying attention to the dose, time, and method of calcification and fertilization. This study aims to obtain information about the P uptake of soybean plants (*Glycine max* L. (Merr)) on cambisol soil after lime and phosphate fertilizer application, which was carried out in Poka Village, Teluk Ambon Baguala District, Ambon City. This research took place from September 2022 to February 2023. Soil and plant analysis was carried out at the Soil Laboratory, Faculty of Agriculture, University of Pattimura. The experimental design used in this study was a factorial complete randomized design (CRD) with three replications, where the parameter studied was the P uptake of soybean plants. The results showed that the optimal combination of lime and phosphate fertilizer doses on cambisol soil could increase the P uptake of soybean plants.

Keywords: Phosphate, P uptake, Cambisol, Lime, Soybean (Glycine *max* L. (Merr)).

I. INTRODUCTION

Soybean (*Glycine max* L. (Merr)) is an annual dicot herb with little branching, a taproot root system, and cambium stems. Soybeans can change their appearance into semi-vines in low light conditions. Soybean is an annual plant, an upright plant with a height of 40-90 cm, and has many leaves [1]. Root nodules on soybean roots play an important role in the process of nitrogen fixation which is needed by soybean plants for their continued growth [2]. Soybean productivity depends on the type of soil and the nutrients contained in the soil. The availability of good nutrients can be absorbed by plants to ensure plant growth and production [3].

One type of soil that can be used for soybean cultivation is cambisol soil. Cambisols have a texture that varies from coarse to fine, the effective depth varies from shallow to deep, in the lowlands it is generally thick [4]. Cambisol soil is acidic mineral and has unfavorable chemical properties [4], such as low soil pH, high Al saturation, low to moderate organic matter content, and relatively low soil fertility, so it needs attention in efforts to increase soybean production.

The way to get nutrient availability for acid soils in order to get optimal soybean production is by liming and fertilizing. Giving lime will increase soil pH, availability of Ca and Mg , and reduce the concentration of aluminum in the soil thereby reducing the potential for plant poisoning. Giving lime also improves the formation of nodules on the roots of leguminous plants and reduces the concentration of acid cations, increases seed size so that a high increase in pod yield is achieved [5] . Fertilization is carried out to maintain and increase the availability of substances that contain one or more nutrients in the soil which is intended to replace nutrients that have been absorbed from the soil so that plants will grow well and be able to have maximum potential. The ability of plants to form seeds in pods is more determined by the nutrient status available to plants [6]. Phosphorus (P) fertilization is also the addition of nutrients to the soil and can be absorbed by plants, used by soybean plants to achieve optimal crop productivity [7]. Phosphate is able to increase the rate of photosynthesis and produce high protein concentrations causing increased productivity of soybean plants [8].

P uptake in plants is an indicator of plant growth and development, where increased P uptake in plants is also influenced by the spread of roots and the ability of roots to absorb P. According to [9], P uptake is highly dependent on root contact with P in the soil solution. Root distribution in the soil is very important in increasing P uptake and plant dry weight. The application of P fertilizer can improve soil chemical properties as indicated by an increase in pH and available P and a decrease in

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soil Al-dd. Reducing Al-dd will increase root growth and development because the roots do not experience Al poisoning, thus the root hairs absorb more P nutrients causing high plant P uptake. However, it must be noted the large dose given, the time of fertilization and the method of fertilization [10]. Based on this, it is necessary to conduct research on the P uptake of soybean plants (*Glycine max* L. (Merr)) on cambisol soil after lime and phosphate fertilizer application.

II. METHODS

This research was conducted in Poka Village, Teluk Ambon Baguala District, Ambon City, taking place from September 2022 to February 2023. Soil and plant analysis was carried out at the Soil Laboratory, Faculty of Agriculture, University of Pattimura.

The tools used in this study were hand spaiyer, pH meter, scales, destruction tool, hoe, shovel, machete, three gallon plastic bucket, 1/2 inch pipe, 2mm sieve, tape measure, nameplate and stationery. others. The materials used in this study were Cambisol soil as a growing medium for soybean seed plants as the basic fertilizer used Urea (46N) and KCl (60 2 K20) while the treatment material used TSP fertilizer (48 2 P205) and liming was dolomite (CaMg (CO3)2) pesticides are used when plants are attacked by pests, water for watering, as well as other materials for analysis purposes in the laboratory.

The experimental design used in this study was a factorial complete randomized design (CRD) with three replications, where the factors studied were phosphate (p) and liming (k) fertilizers. The dose of fertilizer used was 187.66 kg P205 per hectare because the dose was very high, so half of the dose was used, namely: 93.83 kg P205 per hectare or 203.99 kg TSP per hectare. Meanwhile, the level of liming used was based on the Aldd content of soil analysis results, namely 1.02 me /100 g.

(1). Phosphate fertilizer dosage consists of three levels namely

P0 = without fertilizer
P1 = 46.82 kg of P205 per hectare or 0.92 grams of TSP per plant.
P2 = 93.83 kg P205 per hectare or 1.84 grams of TSP per plant.

(2). The level of calcification consists of three levels, namely:

K0 = without lime
K1 = 0.5 x Al_{dd} or 3.76 grams of dolomite per pot
K2 = 1.0 x Al_{dd} or 7.51 grams of dolomite per pot

The implementation of the research carried out was soil preparation, fertilization, planting, maintenance, harvesting, and soil and plant analysis. Soil preparation is done by taking the soil, profiles are made in the field to evaluate the correctness of the cambisol soil type based on the soil map. The soil was taken from 0 - 30 cm deep, allowed to air dry and sieved with a 2 mm sieve. From the results of the analysis Al_{dd} Aluminum can be exchanged to be used to determine the amount of lime that must be added according to the fertilization treatment. Liming and fertilizing were carried out in this way , liming was carried out two weeks before planting, the lime was put into the experimental pot according to the treatment then mixed until evenly distributed. Urea and KCl fertilization as basic fertilizers were given simultaneously at the time of planting and applied directly to all plants in each experimental pot with a distance of 10 cm from the plants and a depth of 5 cm. Likewise with the provision of TSP as treatment.

Planting was done with a 3 cm deep drill system and three seeds were added to each drill. Before planting, soybean seeds are inoculated with legium according to the dosage, namely 5 g legin/kg soybean seeds, by soaking the seeds in 1 legium mixed with water. Maintenance by replanting the soybean plants, carried out around the age of one week, along with thinning the plants by leaving one of the best plants in each pot. The point is that there is no competition for nutrients and sunlight. Weeding is done twice, first at the age of 15 days after planting and must be maintained until it damages the plant roots. The second weeding is done when the plants are 30 days old and done at the same time by loosening as needed to maintain good soil aerase and drainage. Watering can be given at the same time as planting, and the water content is maintained at field capacity.

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At the end of the study, the soil was taken from each experimental unit and allowed to air dry and sieved through a 2 mm sieve to analyze PH (H_2O 1 : 2.5), available P (Bray-1), interchangeable packaging (Al_{dd} + Hdd). In addition to soil analysis, plant analysis was also carried out to determine absorbed P or leaf phosphate content (%). For this purpose some soybean leaves that have opened completely are taken and put into the laboratory for analysis. The results of the research were the P uptake of soybean plants in the treatment which had a significant effect followed by a different test of means, namely Duncan's Multiple Range test with a level of 5%.

III. RESULTS AND DISCUSSION

The results of the analysis of diversity showed that the P uptake of soybean plants on cambisol soil was significantly affected by liming and fertilization phosphates, as well as the interactions between the two. In Table 1, it can be seen that in the treatment (P0 and P1), it was evident after lime was given up to level (K2). This is due to the relative availability of soil P low so as to increase the uptake of P Soybean plants require a lime level of (K2). While in the treatment of phosphate fertilization (P2), each an increase in lime level will be followed by a significant increase in soy plant P uptake . An increase in lime levels causes the availability of soil calcium (Ca) nutrients. Ca in the soil plays a positive role in the growth of root tips and root hairs. Thus increasing the level of lime, will have an impact positive effect on plant root development. Good plant root development will have an impact on increasing nutrient uptake by plants [11] . In addition, according to [12], lime is a source of ameliorant which is effective in improving soil quality, namely (1) improving soil physical properties (increasing granulation for soil aeration), (2) improving soil chemical properties (decreasing H, Fe, Al and Mn as well as increasing the availability of Ca, Mg, P, and (3) improving soil biological properties (increasing microbial activity), thus increasing plant growth including root development.

The contribution made by liming to plant P uptake varies according to the different doses of phosphate fertilizer used. At doses of phosphate fertilizers P0, P1 and P2, the contribution of calcification to P uptake by soybean plants was 91 percent, 76 percent and 86 percent, respectively. This high presentation indicates that liming affects plant P uptake which causes increased growth and development of soybean plants. The growth and development of soybean plants causes increased production of soybean plants [13]. Lime treatment shows an important role in the provision of nutrients and metabolic processes in plants so as to ensure the availability of nutrients in the generative growth phase of plants so that soybean crop production increases. According to [14], one of the efforts to increase soil pH, reduce Al content or saturation, increase Ca and/or Ca and Mg content, as well as improve land P availability is the application of lime. The results of the study [15], showed that liming had a significant effect on increasing soil pH, an increase in pH was caused by a decrease in the content of Al3 and H+ due to the addition of lime in the soil, as a result there was a contribution of alkaline cations such as Ca2+ and Mg3+ which directly affected the binding of OH- ions in the soil. This has an effect on increasing soybean production [16].

The remaining P uptake by soybean plants of 9 percent for K0, 24 percent for K1 and 14 percent for K2 is influenced by other factors (besides liming and P fertilization factors). According to [17], the uptake of element P by plants is also influenced by the presence of element N in the soil. Nitrogen (N) is one of the most essential macronutrients and has a role in stimulating plant growth in general, especially in the vegetative phase, playing a role in the formation of chlorophyll, forming fats, proteins and other compounds. N has the same macro elements as P, so if there is naturally a lot of N in the soil, it will be absorbed by plants so that the absorption of P is reduced causing low P in soybean plants [18]. In addition, the low P uptake of soybean plants by 9 percent is thought to be due to phosphate (P) being fixed by aluminum (Al) and iron (Fe) and manganese (Mn) substances causing phosphorus (P) not to be absorbed optimally by plants which causes p low soybean plants [19].

The results of the different tests (Table 1) show that at all levels of calcification (K0, K1 and K2) , and an increase in the dose of fertilization phosphate will cause significant increase in plant P

uptake. This is due to each increase in the dose of phosphate fertilizer (P) always followed by an increase in soil P availability so that it has the effect of increasing P uptake by plants. This is in line with research [20], which found that phosphorus in the soil was absorbed by plants and distributed to living cell parts, especially to the reproductive parts of plants. [21] added , that the supply of phosphorus will have an impact on the quality of plants. Phosphorus is actively absorbed by the roots from the soil solution and stored in the plant body in high concentrations [22]. If the P supply increases, it can accelerate plant development [23]. The dose of P fertilizer in this study showed an effective dose in increasing the production of soybean plants. According to [24], effective fertilization, namely the right type of fertilizer and the right dose, can accelerate and strengthen the growth of young plants into mature plants [25];[13], thereby increasing soybean production [26].

T able 1. Interaction between liming and phosphate fertilization on P uptake by soybean plants on cambisol soil

Fertilizer dosage	**%P Leaves**		
	K 0	**K 1**	**K 2**
P0	0.14a (A)	0.18a (A)	0.23a (B)
P1	0.25b (A)	0.26b (AB)	0.29b (B)
P2	0.30c (A)	0.33c (B)	0.38c (C)

Information: Numbers followed by the same letter are not significantly different at BNJ 0.0 5 (0.04). Uppercase letters are read horizontally, lowercase letters are read vertically.
P0 , P1 , P2 _ : respectively were 0 g , 0.92 g and 1.84 g TSP per plant
K 0, K 1, K 2 : respectively 0 g , 3.76 g, and 7.51 g of dolomite per pot.

The effect of liming on the increased absorption of P real after lime level (K1) at P2 fertilizer doses. This is because lime has an effect on increasing the availability of soil P, and reducing the concentration of Al dd in the soil, resulting in an increase in P uptake by soybean plants. Decreased concentration of Al in soil solution , will have an impact on increasing P uptake by plants. This is because phosphorus is added to the soil, some of it will be bound by aluminum so that phosphorus is not available to plants, even though the soil conditions are very good[27], conversely if the concentration of aluminum is low in the soil then the phosphorus added to the soil can be absorbed by plants so that P plant increases. In addition , reducing the concentration of Al in the soil solution will prevent damage to plant roots. On the other hand, an increase in Al concentration in the soil causes root damage, which directly inhibits P uptake by plants [28] .

IV. CONCLUSIONS

The combination of lime and the optimal dose of phosphate fertilizer on cambisol soil can increase the P uptake of soybean plants.

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