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THE EFFECTS OF LIME AND PHOSPHATE FERTILIZATION IN CAMBISOLE SOIL ON DRY SEED WEIGHT OF SOYBEAN (*Glycine max* L. (Merr))

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Abstract. Optimal soybean (*Glycine max* L. (Merr)) production can be done by liming and fertilizing. This research aims to obtain information about the effect of liming and phosphate fertilization in cambisol soil on the dry seed weight of soybean plants (*Glycine max* L. (Merr)). This research was carried out in Poka Village, Teluk Ambon Baguala District, Ambon City, taking place from February to July 2023. Soil and plant analysis was carried out at the Soil Laboratory, Faculty of Agriculture, Pattimura University. The experimental design used in this research was a Randomized Step Design (CRD) with a factorial pattern with three replications, where the parameter studied was the dry seed weight of soybean plants. The results of the study showed that the contribution made by liming to increasing the dry seed weight of soybean plants was relatively smaller compared to the larger phosphate (P2O5) fertilization.

Key words : Phosphate, Cambisole, Lime, Soybean (*Glycine max* L.(Merr)).

I. INTRODUCTION

Soybean (*Glycine max* L. (Merr)) is an annual plant, an upright plant with a height of 40-90 cm, and has many leaves. Soybeans have a root system consisting of a tap root which is formed from prospective secondary roots which are arranged in four rows along the tap root, secondary root branches, and adventitious root branches which grow from the bottom of the hypocotyl (Adie and Krisnawati, 2007 in Yusuf, *2019*) . The root system of soybean plants is characterized by a symbiotic interaction between root nodule bacteria (*Rhizobium japanicum*) and the roots of soybean plants which causes the formation of root nodules. Root nodules play an important role in the process of nitrogen fixation which is needed by soybean plants for continued growth (Pratama, 2019). Efforts to improve the quality of soybean productivity do not only depend on the type of soil used but must also pay attention to the nutrients contained in the soil. The availability of complete and balanced nutrients that can be absorbed by plants is a factor that determines plant growth and production (Prakoso *et al* ., 2020).

One type of soil that can be used for soybean plants is cambisol soil. The distribution of cambisol land in Indonesia is around 17,160 million Ha and in Maluku it is spread over 0.331 million Ha, while in Ambon, based on a 1:1,000,000 scale soil map, the area of cambisol land is around 22,129 Ha. Cambisol is a type of soil that is classified as newly developing soil which has the potential for the development of agricultural crops, usually has a texture that varies from coarse to fine, the effective depth varies from shallow to deep, in the lowlands it is generally thick, while in steep slope areas the solum is thin (Tufaila and Alam, 2014 *in* Rahmi *et al* ., 2019). Cambisol soil is an acid mineral soil that needs attention in efforts to increase food production such as soybeans. This is because cambisol soil generally has poor chemical properties (Rahmi *et al* ., 2019), such as low soil pH, high Al saturation, low to moderate organic matter content, and relatively low soil fertility levels.

To obtain nutrient availability for acidic soil in order to obtain optimal production, chemical properties improvement measures such as fertilization, liming and application of organic material are needed. Plants need 16 essential nutrients which are divided into two parts, namely macro and micro nutrients. Plants need macro nutrients in greater or greater amounts than micro nutrients. Soybeans absorb the macro nutrients Nitrogen (N) and Phosphorus (P) in relatively large amounts, so that for each hectare per soybean plant the amount of N and P used by soybean plants is greater than other plants to achieve optimal productivity (Indrawan et *al* . , 2018).

Applying lime will increase soil pH, the availability of Ca and Mg , and reduce the concentration of aluminum in the soil, thereby reducing the potential for poisoning to plants. Applying lime also improves the formation of root nodules in legume plants and reduces the concentration of acid cations, increases seed size so that a high increase in pod yield is achieved (Anwar, 2019) . Fertilization is carried out to maintain and increase the availability of substances containing one or more nutrient elements in the soil which are 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 determined more by the status of the nutrients available to the plant (Santana *et al* ., 2021). Soybean is a plant that requires quite a lot of nutrients to obtain good fruit and seed production. The main nutrient that needs to be added to fertilize soybean plants is phosphate. Phosphate is able to increase the rate of photosynthesis and produce high protein concentrations, causing increased productivity of soybean plants (Wang *et al* ., 2018; Subaedah *et al.,* 2019; Subaedah *et al.,* 2021).

Phosphate fixation maintains a pH of 6.0 and 7.0 so that phosphate and its uptake increase causing increased plant production. Providing phosphate (P) fertilizer to soybean plants can stimulate the growth of new roots, the formation of a number of proteins, help assimilation and respiration, stimulate the formation of flowers, fruit and seeds (Siregar et al., 2017; Opala *et* al . , 2018). According to Panggabean, (2017) and Hawayanti *et al* ., (2022), fertilization is carried out by paying attention to several things, namely the plant being fertilized, the type of soil, the type of fertilizer used, the dose given, the time of fertilization and the method of fertilization. Based on these facts, it is necessary to conduct research on the effects of liming and phosphate fertilization in cambisol soil on the dry seed weight of soybean plants.

II. RESEARCH METHODS

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

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

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

(1). The dosage of phosphate fertilizer consists of three levels, namely

P0 = no fertilizer

P1 = 46.82 kg P205 per hectare or 0.92 grams TSP per plant.

P2 = 93.83 kg P205 Per hectare or 1.84 grams of TSP per plant.

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

Planting is done using a tube system to a depth of 3 cm and three seeds are inserted into each tube. Before planting, the soybean seeds are inoculated with legium according to the dosage, namely 5 g legin/kg soybean seeds. This is done by soaking the seeds in 1 legium mixed with water. Maintenance by replanting soybean plants, is carried out at around one week of age, along with thinning the plants by leaving one best plant per pot. This means that there is no competition for nutrients and sunlight. Weeding is done twice, namely, first at 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 is done at the same time with loosening as necessary to maintain good aerase and soil drainage. Irrigation can be provided at the same time as planting, and the water content is maintained at field capacity.

Harvesting of soybeans is carried out when the soybeans are old enough, namely 75 - 110 after planting, showing signs that the pods are old, the leaves turn yellow, then fall, the fruit begins to change color from the seeds to brownish yellow and cracks, the stems are yellow, slightly brown and bare. . The harvest results are dry seeds and then weighed. At the end of the research, soil was taken from each experimental unit and allowed to air dry and sieved with a 2 mm sieve to be analyzed for PH (H_2O 1 : 2.5), available P (Bray-1), exchangeable packaging (Al_{dd} + H_{dd}). The data from the research, namely the dry seed weight of soybean plants in the treatment which had a significant effect, was followed by a mean difference test , namely the Duncan's Multiple Distance test with a level of 5%.

III. RESULTS AND DISCUSSION

Analysis of diversity showed that the dry seed weight of soybean plants was very significantly influenced by lime and phosphate fertilization (Table 1), as well as the interaction between the two.

Table 1. Interaction between liming and phosphate (P) fertilization in cambisol soil on dry seed weight of soybean plants

Fertilizer Dosage	**Soybean Plant Dry Seed Weight (g)**		
	K0	**K1**	**K3**
P0	3.54 a (A)	4.05 a (A)	5.68 a (A)
P1	6.03 a (A)	12.01 b (B)	13.02 b (B)
P2	12.89 b (B)	13.94 b (A)	22.92 c (B)

Note: Numbers followed by the same letter are not significantly different at BNJ 0.05 (3.89). Uppercase letters are read horizontally, lowercase letters are read vertically.
P0, P1, P 2 : respectively 0 g, 0.92 g and 1.84 g TPS per plant
K0, K1, K2: respectively 0 g, 3.76 g and 7.51 g of dolomite per pot.

Different tests in table 1 show that in the K0 treatment > increasing the dose of phosphate fertilizer up to (P2), caused the dry seed weight of the plants to increase significantly. This is thought to have occurred due to P levels not being met. Increasing the dose of phosphate fertilizer from P0 to P1 in the treatment without lime (K0) caused the leaf P percentage to increase from 0.14 percent to 0.25 percent. These two percent P values have not yet reached the minimum percent for growth and production of soybean plants, because the minimum limit for percent P in leaves which indicates the minimum adequacy of P nutrients in plant tissue is 0.26 percent, and if the percent P in tissue shows a value below this limit above (0.26%), then the plant experiences phosphorus deficiency in the tissue.

In table 1, it can be seen that in the P0 treatment , increasing the level of lime did not show a significant effect on increasing the dry seed weight of soybean plants . This is caused by fertilizer treatment P 0, Increasing the level of lime has not been able to increase P uptake plant . Treatment without phosphate fertilization (P 0), increase in lime level from K 0 to K1 and K1 to K2 causes an increase in plant P uptake . However, the value is below the minimum m percent soybean plants, so that their impact on increasing the actual weight of dry beans is not yet visible. The descriptions above can be used to discuss differences in dry bean weight due to increase lime level, at fertilizer doses P 1 and P 2 . Thus, if the test is different (Table 1) it shows that at fertilizer dose P1 , increase in lime level from K 0 to K1 have differences in dry seed weight , whereas for the same fertilizer dose (P 1) The increase in liming from K1 to K2 does not show a significant increase from the weight of the dry beans.

In Figure 1 , it can be seen that the donations were given by liming to increase dry seed weight soybean crops at lime levels K 0 , K1 and K2, respectively also 46 percent, 56 percent and 58 percent. This shows that the contribution made by liming to increasing the dry seed weight of soybean plants , in general relatively smaller compared to the contribution provided by phosphate fertilization . This is because liming has more potential small impact on increasing crop P uptake , compared to the potential of phosphate fertilization in increasing P uptake by plants . Apart from that, it is suspected that liming in the research was not enough to react because there was influence from Al or Fe so it was not able to increase soybean productivity including dry seed weight (Irwan and Nurmala , 2018). Another opinion by Rahman *et al* ., (2021), is that liming has not had an effect on the dry seed weight of soybean plants because not all lime doses have been given . can be absorbed by plants, some will be left behind as residue that can be used by subsequent plantings, and some will be lost in various ways such as evaporation, leaching, or use by weeds and microorganisms in particular.

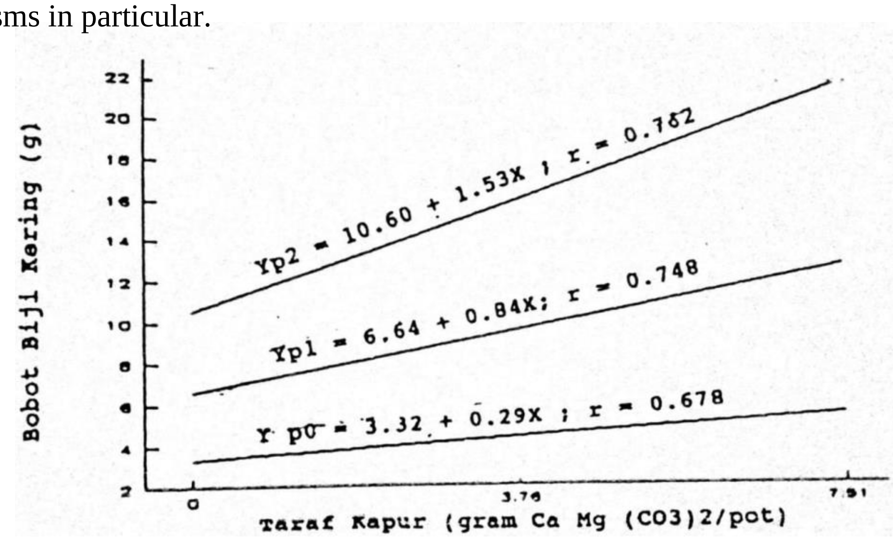

Figure 1. Relationship between the level of liming and the dry seed weight of soybean plants at each dose of phosphate fertilization.

In this study, the dry seed weight of soybean plants was influenced by phosphate fertilization. This happens because P helps the formation of very high levels of protein and minerals for plants and then circulates energy throughout all parts of the plant , thus stimulating root growth and development. Accelerates the flowering and fruiting of plants, and accelerates the ripening of fruit and seeds. According to Nainggolan *et al* ., 2017 and Yusuf *et al* ., (2017) and Putri *et al* ., (2022), phosphorus (P) is part of the cell nucleus that is important in cell division, stimulates and accelerates the flowering process and ripening of heavier fruit and seeds.

In plants, the role of phosphorus is related to biochemical mechanisms that store energy and then transfer it into living cells, including as a component of ATP, nucleic acids, and many metabolic substrates, as well as as an enzyme cofactor. Phosphorus also participates in the phosphorylation of various intermediate compounds of photosynthesis and respiration . (Loveless, 2000 *in* Mustikawati *et al* ., 2020). Apart from that , phosphorus (P) also plays a role as a constituent of important structural components such as phospholipids in membranes, phosphorylation of sugars and proteins, and as an integral part of DNA and RNA (Mustikawati *et al* ., 2020).

Due to its important role phosphorus in the formation of carbohydrates, fats and proteins , so every increase in plant P will cause an increase in the dry seed weight of soybean plants . This is because soybean seeds are composed of 35 percent carbohydrates, 18 percent fat and 35 percent protein. Providing phosphate fertilizer in stages has a significant effect on increasing the dry seed weight of soybean plants (Etika *et al* ., 2017). According to Hidayah *et al* ., (2020), the application of biological fertilizer containing P has an effect on increasing the dry seed weight of plants as a result of increased plant P uptake for each increase in the dose of phosphate fertilizer. Because b increases the height Plant P will have a positive effect on formation of carbohydrates, fats and proteins. P is an important component of compounds for energy transfer (ATP and other nucleoproteins), for genetic information systems, for cell membranes (phospholipids) and phosphoproteins (Gardner *et al* ., 1991 *in* Ahdiyanto *et al* ., 2018).

IV. CONCLUSION

The experimental design used in this research was a Randomized Step Design (CRD) with a factorial pattern with three replications, where the parameter studied was the dry seed weight of soybean plants. The contribution made by liming to increasing the dry seed weight of soybean plants is relatively smaller compared to the larger phosphate (P2O5) fertilization.

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