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Cucumber (*Cucumis sativus* L.) Growth and Yield as Respons by Dolomite and Potassium Application on Peat Soil

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ABSTRACT

This study aimed to determine the appropriate dose of dolomite, dose of K fertilizer, and the interaction of the treatments on the growth and yield of cucumber on peat soil soil. This research was conducted in Medan Baru, Muara Bangka Hulu Sub-district, Bengkulu City at an altitude of ± 10 meters above sea levelfrom September to December 2021. The experiment method used was a factorial Randomized Complete Block Design (RCBD) consisting of two factors; first, dose of dolomite with 3 levels consisting of 0.00 tons ha^{-1}, 1.25 tons ha^{-1}, and 2.5 tons ha^{-1} Dolomite, and the second, dose of potassium fertilizer consisting of 4 levels; 0 kg ha^{-1}, 200 kg ha^{-1}, 400 kg ha^{-1}, and 600 kg ha^{-1} with 3 replications. Each unit of the experiment pot was planted with 3 plants therefore whole samples were obtained 108 experimental plant units (polybags). Cucumber growth and yield significantly responded to the dolomite and potassium application. The interaction between the dolomite and the potassium applied significantly to the cucumber planted shown by plant length, the diameter, and length of the fruit.

Keywords: cucumber growth and yield, dolomite and potassium application, peat soil

INTRODUCTION

Cucumber (*Cucumis sativus* L.) is a type of fruit-vegetable plant from the gourd family (Cucurbitaceae) that has the property of spreading or propagating through a spiral-shaped holder. Cucumber comes from the northern part of India, namely the slopes of the Himalayas, which later developed into the Mediterranean region (Yulianto *et al*., 2021). Cucumber is very potential to be developed because it has very good business opportunities in the future. This commodity is quite easy to care for and the harvest time is not too long. Apart from that the mushrooming of restaurants, eateries, and cafes have also created additional demand for cucumbers.

The cucumber plant is a type of fruit vegetable that is very popular and known in almost every country (Zulkarnain, 2013). The nutritional content of cucumber plants is quite high, namely 0.65% protein, 0.1% fat, and 2.2% carbohydrates, calcium, iron, magnesium, phosphorus, and vitamins A, B1, B2, and C. Cucumber also contains 35,100 – 486,700 ppm of linoleic acid. Cucumber plants have quite bright business prospects, because the results of cucumber plants are not only marketed domestically (domestic), but also abroad (exports), and for the current market, Japan is the most potential market (Wijoyo, 2012). A constant and stable market for cucumbers has made this commodity the product of choice for farmers (Dipayanti *et al*., 2020). Bengkulu Province has the potential for peatlands of nearly 170 thousand hectares which are divided into several areas, namely agricultural cultivation areas, protected forests, and potential reclamation areas with a proportion of 47.5% each; 1.8%, and 50.7%.

Cucumber production in Bengkulu Province in 2017 was 8,685 tons ha^{-1}, in 2018 production was 7,830 tons ha^{-1}, and in 2019 it was 9988 tons ha^{-1} and in 2020 cucumber production reached 12,090 tons ha^{-1} (BPS, 2021). Due to the high market demand, it is necessary to increase production. One effort to increase crop productivity is by utilizing existing land, namely peat land.

Peat is an accumulation of dead plant residues, both of which can still be identified in shape, or those that cannot be recognized anymore because they have decomposed. Peat is generally found in basins that are saturated with water and have been buried for a long time (thousands to millions of years ago). Water-saturated conditions in the basin create anaerobic conditions, so the process of organic matter accumulation is faster than the rate of decomposition. Peat land area in Indonesia is 20.6 million ha and in the South, Kalimantan is 1.484 million ha (Arsyad, 2011). Some peatlands are still used by the community for plantation cultivation or horticulture, one of which is cucumber cultivation.

Peatlands have great potential to be used as areas for developing crops, although there are still several obstacles such as the chemical, physical and biological properties of the soil. Problems with peatlands can be overcome by improving their chemical properties which are closely related to the availability of nutrients for plants. This can be done by using liming so that the acidity of the soil will be reduced. One of the widely used agricultural lime is dolomite lime ($CaMg(CO_3)_2$) which is one of the limes used to neutralize soil acidity, especially on peat soils (Gultom & Mardaleni, 2014).

The effect of lime on peat soils can improve soil pH, and base saturation (KB), increase the elements of calcium (Ca) and magnesium (Mg), and reduce the availability of toxic organic compounds. Giving lime can also reduce the level of plant poisoning by Al and increase soil fertility. Based on the research results of Taufiq *et al.* (2007), applying dolomite equivalent to ¾ Al-dd on acid soils can increase soil pH, Ca, and Mg availability, and reduce available Al-dd, H-dd, Fe, and Mn. Meanwhile, the addition of dolomite equivalent to ¼ Al-dd on dry, acidic land (pH 4.7 and Al saturation 15%) can increase soybean productivity by 43%. Giving lime 0.5-2 ton ha^{-1} CaCO 2 weeks before planting increased Ca-dd and decreased Al-dd. Lime application of 2 tons ha^{-1} increased soil pH from 4.46 to 5.00, reduced Al-dd content from 3.05 me 100 g^{-1} to 0.75 me 100^{-1}, and increased soybean yield from 1.80 tons ha^{-1} to 2.10 tonnes ha^{-1} (Koesrini & William, 2009).

The results of research by Lestari *et al.* (2007) stated that the vegetative growth of plants could be better with the addition of dolomite as a provider of calcium taken from the soil as Ca^{2+} cations, availability of Ca^{2+}, and other elements. The results of other studies also show that the application of dolomite lime can improve soil chemical properties and increase soybean yields in peatlands.

In addition to providing dolomite fertilizer, potassium fertilizer also plays a role in improving the quality of melon fruit such as fruit size, fruit flesh thickness, fruit texture, fruit aroma, and fruit sweetness level. Potassium fertilizer plays a role in enzyme activation, the opening of stomata in the process of photosynthesis, and increasing root growth which plays a role in the formation of carbohydrates, absorbing nutrients and water (Jasmi, 2016). Potassium fertilizer also plays a role in synthesizing sucrose from glucose and fructose (Lester *et al.*, 2010).

According to Farizaldi (2014), potassium fertilization in plants is useful for increasing plant vigor, making plants more resistant to disease, producing better plant roots, reducing negative effects due to Nitrogen (N) fertilization, affecting cooking time which may be too fast by phosphorus fertilization (P), regulates the balance of N and P fertilizers, especially in mixed fertilization, helps the formation of carbohydrates and the process of translocation of sugars in plants, helps form chlorophyll, and increases the weight of cereal seeds so that crop yields become fuller.

Pradana *et al.* (2015) stated that element K is absorbed by plants in the form of K+ ions, where this element found in the soil in complex compounds and is bound by minerals or salt solutions. Increasing the use of N and P fertilizers will generally increase the use of potassium fertilizers. Element K has special characteristics when compared to other elements, where excess K in the soil does not negatively affect plants. This causes the loss of K in the soil to be much greater than expected because plants can absorb K over their actual needs. Apriliani *et al.* (2016) stated that potassium fertilization had a significant effect on the number of branches, length of plant tendrils, length of roots, number of leaves, fresh weight of plants, tuber diameter, and tuber weight of plants.

The results of other studies stated that giving potassium at a dose of 400 kg ha^{-1} KCl resulted in the highest sweetness level of melon fruit of 8.2°brix (Handajaningsih *et al.*, 2018). Giving potassium at a dose of 500 kg ha^{-1} KCl gave the highest plant height, number of bulbs, and fresh weight of shallot bulbs. This is because the availability of nutrients in the soil is well available (Qolby *et al.*, 2018). The results of the research by Raziliano *et al.* (2015) showed that the use of Potassium Fertilizer on chili plants at a dose of 600 kg ha^{-1} gave the best average growth and yield on peatlands. The results of the research by Hudah *et al.* (2019) pruning the 12th internode shoots and a dose of 300 kg ha^{-1} potassium fertilizer on cucumber plants was able to give the best results. This is expected to improve the texture and structure of the peat soil planting media to support the growth and yield of cucumbers, so it is necessary to research to obtain the growth response and yield of cucumbers on peat growing media.

MATERIALS AND METHODS

This research was carried out from September to December 2021. The research location was located in Medan Baru, Muara Bangka Hulu District, Bengkulu City at an altitude of ± 10 m asl (above sea level). The tools used in this study were hoes, polybags, fence nets, gembor, scales, calipers, buckets, sacks, ovens, markers, ropes, calculators, rulers, and digital scales. The materials used in this study were Bandana F1 hybrid cucumber seeds, potassium fertilizer, dolomite, urea fertilizer, P fertilizer, pesticides, and carbofuran.

This study was arranged in a factorial Randomized Complete Block Design (RCBD) consisting of two factors. The first factor is dolomite dosage. The second factor is potassium fertilizer. From the two treatments used, 12 treatment combinations were obtained and each treatment was repeated 3 times to obtain 36 experimental units. Each experimental unit contained 3 plant samples so 108 experimental plant units (polybags) were obtained.

The research implementation included soil analysis, planting media preparation, labeling, seed provision, planting, fertilizing, maintenance, and harvesting. The observed variables consisted of Plant Length (cm), Stem Diameter (mm), Fruit Diameter (cm), Fruit Length (cm), Fruit Weight (g), Number of Fruits per Plant, Canopy Dry Weight (g), Root Dry Weight (g).

Observational data were analyzed statistically using analysis of variance with the F test at the 5% level and the average comparison between treatments was done with the DMRT at the 5% level.

RESULTS AND DISCUSSION

The results of the analysis of variance showed that there was an interaction between dolomite and potassium fertilizer doses on the variable stem diameter and fruit weight per planting (Table 1). The application of dolomite to cucumbers had a very significant effect on the variable plant length, stem diameter, fruit weight planted, number of fruit planted, shoot dry weight, and root dry weight and had a significant effect on fruit diameter and fruit length Potassium Fertilizer Treatment had a very significant effect on the variable number of fruit plants and had a significant effect on the variables Plant Length, Fruit Diameter, and Fruit Length while on the Stem Diameter, Fruit Plant Weight, Canopy Dry Weight, and Root Dry Weight Variables had no significant effect.

Interaction of dolomite and potassium fertilizers

The treatment of dolomite and potash fertilizers gives a noticeable interaction with the variable diameter of the stem and the amount of fruit weight per plant. Treatment of potassium fertilizer with a dose of 400 kg ha^{-1} resulted in the highest stem diameter growth of 5.75 cm at the application of dolomite 2.5 tons ha^{-1}. The application of dolomite 1.25 tons ha^{-1} had a significant effect on the application of potassium fertilizer at a dose of 600 kg ha^{-1}. It is suspected that the application of dolomite to cucumber plants has not been well absorbed by plants so there has not been a very visible response to the growth of stem diameter treated with dolomite, but it has an impact on other growths. However, the dose of potassium and dolomite affected the growth of stem diameter, as at a dose of 400 kg ha^{-1} potassium, the growth of stem diameter was the highest (Table 2). Good plant growth depends on the availability of nutrients needed by plants.

In line with the opinion of Safuan *et al.* (2012) that the availability of nutrients for plants is one of the factors that greatly influence crop production. The optimal dosage of potassium fertilizer for melon cultivation is 150 kg which can produce fresh melons weighing 2.60 kg tree^{-1} or 54.60 tonnes ha^{-1}. Sianturi *et al.* (2014) stated that potassium is a nutrient that functions to form and stimulate protein and carbohydrate synthesis, stimulate root growth and development, increase root turgor pressure, and increase nutrient absorption.

Table 1. Analysis of variance of dolomite and potassium fertilizer application on growth and yield of cucumber

Variable	F value			CV (%)
	Interaction	Dolomite	Potassium	
Plant length	17.31	40.09**	21.03*	18.00
Stem diameter	3.28*	6.12**	1.26*	15.11
Fruit diameter	1.35	5.33*	3.16*	20.26
Fruit length	1.89	5.62*	4.02*	20.04
Number of fruits per plant	0.23	1.49**	0.31	16.18
Fruit weight per plant	3.89**	14.35**	7.34**	18.53
Canopy dry weight	2.33	7.22**	1.49	15.84
Root dry weight	1.56	4.67**	0.63	25.98

Note : * = significant ; ** = highly significant

The application of potassium fertilizer 400 kg ha^{-1} to dolomite 2.5 tons ha^{-1} gives the highest weight of fruit per plant, which is 142.9 g. However, in dolomite 2.5 tons ha^{-1} against the application of potassium fertilizer 200 kg ha^{-1} has a noticeable effect on potassium fertilizer 400 kg ha^{-1}. This was also followed by the interaction of dolomite application of 1.25 tons ha^{-1} to potassium fertilizer 200 kg ha^{-1} and 400 kg ha^{-1} showing a noticeable effect on control plants (Table 3).

It is suspected that the provision of potassium gives a good response to plants so that the K nutrient needs for plants are met, the results of research by Apriliani *et al*. (2016) stated that potassium fertilization had a significant effect on the number of branches, length of plant tendrils, length of roots, number of leaves, number of fruits, plant fresh weight, tuber diameter and fruit weight of the plant.

Table 2. Interaction of potassium fertilizers and dolomite application at variable stem diameter (mm)

Potassium (kg ha^{-1})	Dolomite (tonnes ha^{-1})		
	0	1.25	2.5
0	4.34 ab	3.59 b	5.53 a
	A	B	A
200	5.32 a	5.01 a	4.92 a
	A	AB	A
400	4.19 a	5.17 a	5.75 a
	A	AB	A
600	3.69 b	5.74 a	5.59 a
	A	A	A

Note : Number followed the same capital letter in the column (vertically) and the same lowercase letter in the row (horizontally) are the same different is not real at DMRT 5%

The results of other studies Potassium also plays a role in enzyme activation, the opening of stomata in the process of photosynthesis, improving fruit quality, and increasing root growth which plays a role in the formation of carbohydrates, absorbing nutrients and water, so that the provision of potassium to plants supports the growth of the generative phase of plants such as plant fruit weight (Jasmi, 2016). According to Zarokhmah *et al.* (2021), the role of potassium in plant growth is to help transport and assimilate from leaves to plant tissues, prevent the loss of flowers and fruit, help the process of forming carbohydrates and proteins produced by photosynthesis, help the process of moving stomata which regulates the entry of CO_2 and the release of O_2 into the air. Therefore the application of Potassium and dolomite Fertilizers can increase the availability of nutrients for plants and can improve soil fertility and plant growth and yields.

Growth and yield of Cucumber plants against dolomite application

Plant length and stem diameter are important indicators of vegetative growth of cucumber plants and the variables measured. Giving dolomite treat-

Table 3. Interaction of potassium fertilizer and dolomite application on variable fruit weight per plant (grams)

Potassium (kg ha^{-1})	Dolomite (tonnes ha^{-1})		
	0	1.25	2.5
0	43.3 b	85.5 ab	120.8 a
	B	B	AB
200	127.5 a	132.8 a	107.3 a
	A	A	B
400	70.3 a	121.3 a	142.9 a
	AB	AB	A
600	95.9 a	138.6 a	130.3 a
	AB	A	AB

Note : Number followed the same capital letter in the column (vertically) and the same lowercase letter in the row (horizontally) are the same different is not real at DMRT 5%

The results of research by Lestari *et al.* (2007) stated that the vegetative growth of plants could be better with the addition of dolomite as a calcium provider taken from the soil as Ca^{2+} cations, availability of Ca^{2+}, and other elements. For fruit diameter, the dolomite dose of 2.5 tons ha^{-1} gave the highest fruit diameter, namely 29.80 mm. It is suspected that the $MgCa(CO_3)_2$ content in dolomite can be absorbed well by plants resulting in good growth and yield of cucumber plants.

This agrees with Kuswandi (1993) that the provision of dolomite containing Ca and Mg levels in the soil is an indispensable element in the synthesis of chlorophyll to determine the course of the photosynthetic process. yield from plants. Mg functions as a form of chlorophyll and carbohydrates and can function as an activator in the process of photosynthesis, while the element Ca functions to activate meristem cell division and increase plant organs such as fruit diameter (Kuswandi, 1993).

The fruit length of the plant is an indicator that is measured to see the results of the cucumber plants obtained, so it can be seen in table 3, that the highest average fruit length is in the dolomites of 2.5 tons ha^{-1}, which is 14.70 cm. This is presumably because the higher the dolomite, the higher the decomposition of organic matter due to the higher pH, Ca, and Mg so that the activity of microorganisms increases, the higher the decomposition of organic matter, the greater the available P produced.

This is in line with the opinion of Adikara *et al.* (2019) that phosphate (P_2O_5) functions to transport energy produced by metabolism in plants, stimulates flowering and fertilization, stimulates root growth, stimulates seed formation, stimulates plant cell division and enlarges cell tissue. The fruit weight of the plants showed the highest yield at the application of dolomite 2.5 tons ha^{-1}, namely 325.38 g.

It is suspected that the effect of giving dolomite can meet the needs of macro and micro nutrients for plants such as nutrients N, P, and K so that it has an impact on the yield of fruit weight of the plant. Sutedjo (2012) suggests that phosphorus for plants can also improve generative growth, especially the formation of flowers, fruits, and seeds.

According to Sumarno (2002) that 125 kg TSP ha^{-1} to 250 kg TSP ha^{-1} significantly increased the number and weight of pods per plant, seed weight per plant, and peanut crop yields also increased. The Canopy dry weight of cucumber showed the highest yield at a dose of 2.5 tons ha^{-1}, namely 9.44 g. It is suspected that the application of dolomite can create a healthy environment in the cucumber planting medium, so that soil microorganisms can live well and the macro and micronutrients in the planting medium are fulfilled, especially the nutrients P and N play a role in the growth and upright growth of stems in plants.

According to Djoelistee (2010), there are no other elements that can replace the function of phosphorus in plants, so plants must obtain or contain enough phosphorus to grow normally. The important function of phosphorus in plants is in the process of plant photosynthesis, respiration, energy transfer and storage, enlargement, and cell division. Phosphorus and nitrogen are used to regulate overall plant growth, such as in the parameters of seedling height, shoot dry weight, and root length. On the dry weight of cucumber roots at a dose of 2.5 tons ha^{-1}, the highest yield was 2.89 g.

This is because the administration of dolomite in high amounts can prepare macro and micronutrients in plants so that the nutrient needs for plants are fulfilled. In the growth of plant roots, the macronutrient P available in the soil will affect the growth rate of plant roots. The high element P in the soil can cause most of the photosynthetic results to be distributed more to the canopy for plant growth (Permanasari *et al*., 2016).

This agrees with Rover (2009) that the nutrient P in legume plants also functions for protein formation and stimulates root growth resulting in better plant leaf growth and can increase the weight of forage material at harvest.

Growth and yield of Cucumber plants against Giving Potassium

The application of potassium to plant growth and yield had a significant effect on several observed variables such as plant length, stem diameter, fruit diameter, fruit length, number of fruit planted, and on the variable plant fruit weight, shoot dry weight and root dry weight had no significant effect.Fruit diameter showed the highest yield at a K dose of 600 kg ha^{-1},

Table 4. Average growth and yield of cucumber on dolomite application

Dolomite (tons ha^{-1})	Variable					
	PL (cm)	FD (mm)	FL (cm)	NFP	CDW (g)	RDW (g)
0	35.70 b	23.32 b	11.3 b	1.41 b	4.28 b	0.52 b
1.25	65.82 a	29.78 a	14.23 a	2.43 a	7.71 a	2.77 a
1.5	63.05 a	29.80 a	14.7 a	2.87 a	9.44 a	2.89 a

Note : Number followed the same letter in the column (vertically) are the same different is not real at DMRT 5%; PL = Plant Length; FD = Fruit Diameter; FL = Fruit Length; NFP = Number of Fruits per Plant; CDW = Canopy Dry Weight; RDW = Root Dry Weight

According to Lakitan (2000) K can be used as an activator for various essential enzymes in photosynthesis and respiration, as well as enzymes that play a role in starch and protein synthesis. Through photosynthesis, plants obtain energy for physiological processes of plants. In a study by Pratama *et al* (2021), the effect of giving a dose of potassium fertilizer 225 kg ha^{-1} to apple cucumbers was significantly different from other treatments and was able to increase the diameter of the fruit by 54.08 mm. This is presumably because the process of absorption of photosynthetic results and the need for sunlight and absorption of nutrients is more focused on the formation of fruit which is maximally absorbed by the fruit (Yuriani *et al*., 2019).

Fruit length is an indicator of success in cucumber yield, based on Table 4. Fruit length with a K dose of 600 kg ha^{-1} showed the highest yield, namely 14.94 cm (Table 5). Uliyah *et al.* (2017) also stated that K in plants functions in the process of forming sugar and starch, translocating sugar, activating enzymes, and influencing stomata movement. K+ ions in plant cells can increase the turgidity of the guard cells so that the leaf stomata will open and the process of photosynthesis will take place. Indirectly K helps the process of photosynthesis. Photosynthesis will produce photosynthates in the form of carbohydrates.

The results of photosynthesis will be translocated to all parts of the plant that need it and will be stored as food reserves in certain parts of the plant such as fruit. Adequate K availability for plants will support photosynthesis properly. Therefore, a high rate of photosynthesis can stimulate the amount of assimilation produced by plants so that it can support plant growth and production. This is in line with Makuta (2013), which stated that a dose of 200 kg ha^{-1} of potassium fertilizer had a significant effect on fruit length, but in contrast to the statement by Hudah *et al*. (2019), regarding the application of a dose of 300 kg ha^{-1} potassium fertilizer to cucumber plants can increase the production and quality of cucumber fruit. The location where the cucumber fruit grows affects the length of the fruit where the fruit that grows directly on the axils of the leaves and the single fruit is usually relatively longer and smoother (Daulay, 2020).

Table 5. Average growth and yield of Cucumber against potassium fertilizer

Potassium (kg ha^{-1})	Variable		
	PL (cm)	FD (mm)	FL (cm)
0	38,07 b	23,62 b	11,08 b
200	62,68 a	30,13 a	14,71 a
400	63,64 a	26,20 ab	12,92 ab
600	55,03 ab	30,58 a	14,94 a

Note : Number followed the same letter in the column (vertically) are the same different is not real at DMRT 5%; PL = Plant Length; FD = Fruit Diameter; FL = Fruit Length;

CONCLUSION

The interaction between dolomite and potassium fertilizer is found in the variable stem diameter and fruit weight per plant. Dolomite dose of 1.25 tons ha^{-1} produces plant length, fruit diameter, fruit length, number of fruits per plant, canopy dry weight and the largest root dry weight. K fertilizer dose of 400 kg ha^{-1} produces the largest plant length, fruit diameter and fruit length.

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