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Growth and Yield Responses of Peanuts on Dolomite and Cow Manure Doses

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One of obstacles in peanut (*Arachis hypogaea* L.) development in Bengkulu Province of Indonesia is Ultisol soils, which can inhibit the growth of peanut plants so it is necessary to add dolomite and cow manures. This study aims are to determine the optimal dolomite and cow manure doses for peanut plants. The research used a Randomized Completely Block Design with two treatments in factorial arrangement. The first factor was dolomite doses with 4 treatment levels that are 0, 2.5, 5.0 and 7.5 ton ha^{-1}. The second factor is cow manure with 3 treatment levels that is 0, 10 and 20 ton ha^{-1}. The results showed that dolomite dose of 6.45 tons ha^{-1} in combination of cow manure 20 tons ha^{-1} resulted in the highest pod weights of 37.68 grams $plant^{-1}$, the highest seed weight $plant^{-1}$ of 34.19 grams and the least unfilled pods of 4.79 pieces $plant^{-1}$. The dose of 5.36 tons ha^{-1} dolomite resulted in the total root nodule number of 64.88. The higher dose of dolomite given then tends to higher the average number of pods and weight of 100 seeds of peanut plants. Cow manure application with a dose of 0 to 20 tons ha^{-1} did not affect the growth and yield of peanut plants.

Key words: peanut, cow manure, dolomite and ultisol.

Introduction

Peanut (*Arachis hypogea* L.) is one of the commodities of food crops that have a high economic value and preferre by community due to the content of its nutrition value especially the high protein and fat (Simanjuntak *et al.,* 2014). One of the main constraints in the development of peanuts is less availability of fertile soil to support plant growth. The province of Bengkulu dominated by ultisol soil generally covering an area of 3.44 million ha. Ultisol soil has properties which can inhibit plant growth. Some of the common problems of Ultisol is soil acidity (pH < 4.5 average), high Al content and low organic matter content (RBAT, 2014). The reaction of the soil is low soil acidity which causing the unavailability of required nutrients by plant so that plants may experience deficiency of nutrient elements (Nyakpa, *et. al.,* 1998).

Ultisol soils have a low level of porosity and permeability so that it easily becomes compacted (Joon *et al.,* 2006). The complex problems of

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ultisol required some ways to increase soil productivity. One solution is to use technology that can improve soil conditions. Some materials that could be used to improve the soil condition are dolomite and manure. Dolomite with MgO and CaO content of 20% and 33% is expected to raise the soil pH (Nyakpa *et al*., 1998). It is widely used because it is relatively cheap and easy to obtain. In addition, dolomite can improve the physical and chemical properties of soil, lower Al saturation, increase the content of Ca and Mg, raise soil pH,as well as increase the availability of P. Application of dolomite in exceeds the amount of requirements are not recommended, because besides it is not only wastage but also be harmful to the plants (Kuswandi, 1993).

Organic materials can improve soil aggregation as well as make the structure of the soil to be more easily cultivate and tillage (Joon *et al.,* 2006). In addition to ability of organic materials improve soil fertility are also an important role in improving the physical properties of the soil. Cow manure is one of organic fertilizer. It can be either compacted dung or liquid manure that can improve soil structure, increase soil organic matter and be source of nutrient elements (Farizaldi, 2014). Cow manure contains nutrient elements of 0.40% nitrogen, 0.20% phosphorus, 0.10% potassium, and 85% of water (Ramli, 2014). Peanuts require loose soil in order to be easily penetrated by gynophore so that the formation of the pods will not be inhibited (Habiby *et al*., 2013). The use of dolomite and cow manure will largely determine a production plant. Application of excess fertilizer can also lower the production of peanuts. The use of dolomite and cow manure with the right doses expected to increase growth and crop yield and reduce the production cost (Neltriana, 2015). The purpose of the study is to determine the optimal dose of dolomite at each doses of cow manure, determine the optimal dose of dolomite, determine the optimal dose of cow manure to plant peanuts.

Materials and Methods

This research has been carried out in January to April 2017 at the laboratory of Agronomy in University of Bengkulu in ultisol soil type with a height of approximately 10 meters above the surface of the Sea. This research was arranged in Factorial design in a Randomized Complete Block Design (RCBD) with two treatment factors. The first factor is the dolomites with 4 degrees of treatment i.e. 0, 2.5, 5, 7.5 ton ha^{-1}. The second factor that is cow manure with 3 degrees of treatment i.e. 0, 10, 20 ton ha^{-1}. From these two factors of treatments resulted in 12 combination treatments and repeated 3 times so that become 36 units of the experiment. Tillage is conducted as deep as 20 cm using a hoe until the soil becomes loose and then create several unit of experiments with size 2 m x 2 m, distance between unit experiments is a 50 cm (0.5 m) and the distance between blocks is 1 m. Planting is done by lying seeds as deep as 2-3 cm from the soil surface and

each planting hole is given carbofuran of 10-15 grains. Planting distance used is 40 cm x 20 cm so that resulted in population of 50 plants per experimental unit. Dolomite and cow manure fertilizer were appropriately given two weeks before planting, according the doses of treatments which scattered as side dressing on each experiment plots. Fertilizer of Urea 50 Kg ha^{-1}, SP-36 100 Kg $ha^{-1}$and KCl 150 Kg ha^{-1} was given at early of planting that is according dose recommendations for peanuts plants.

Results and Discussion

Soil used for research is the ultisol soil type with soil that has never been given the treatment earlier. As for the soil pH was 4.40 and the content of Ca 3.15 me/100 grams is still classified as low, so that given the treatment of cow manure, and amendments. After the application of cow manure and dolomite increase the pH and Ca in soils, where the soil pH reached 6.40 and Ca reached 9.16 me/100 grams.

Peanut plant growth indicates a condition that is quite normal and very good overall. Based on the data of climatology during research takes place, as for the rainfall ranges from 172.1 the mm^{-1} month to month 670.8 mm^{-1}, so watering on plants peanuts only performed a few times only and the rest don't do irrigation on peanut plants. At the time of entering the peanut plant 12 weeks after planting visible symptoms of pests namely pigs soil around the footprints of the experiment, so as to avoid loss of the harvest done early harvesting plant peanuts at 12 pm wap are supposed to plant peanut harvesting is done at age 14 weeks after planting.

Interactions influence of Dolomite and Cow Manure dose on Pod weights

Analysis results of the orthogonal polynomial of pod weight response of peanut plants on dolomite at cow manure dose of 0 ton ha^{-1} shows the pattern of positive quadratic response of regression equation with $y_0 = - 0.5859x^2 + 6.0017x + 13{,}591$. The value of the coefficient of determination (R^2) of 0.7035, this shows that only 70.35% of the total variant of fixed variables of Y can be described by the function quadratic. Based on the estimation regression model then optimum dolomite dose is 5.12 ton ha^{-1} so that it will hopefully reach a maximum average weight of pods of 28.96 g/plant.

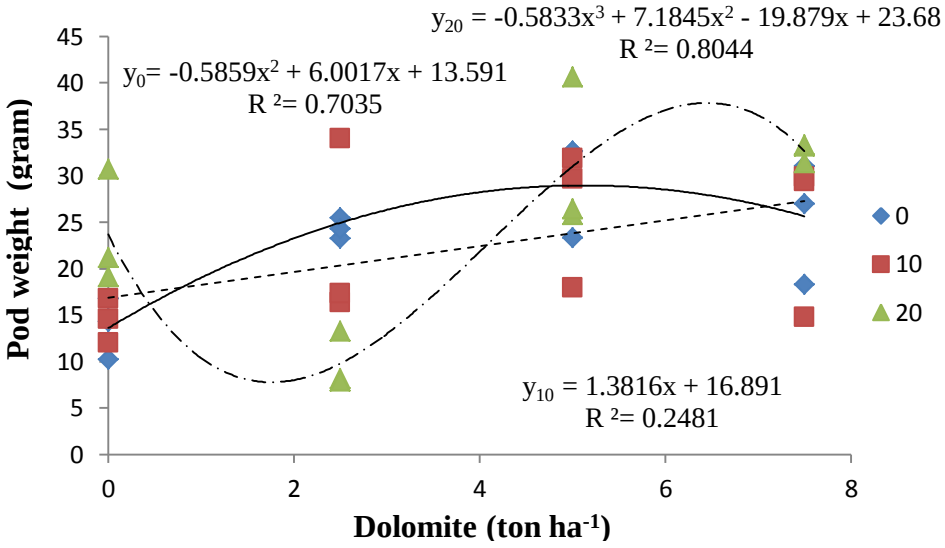

Figure 1. The interaction relationship of dolomite and cow manure dose on pod weights.

Response of pod weights of peanut plant on dolomites at cow manure dose of 10 ton ha^{-1} shows the pattern of regression equations in linear response with y_{10}= 1.3816x + 16,981 (R^2 = 0.2481). Figure 1 shows that an increase in the applying of dolomite up to a dose of 7.5 tons at cow manure dose of 10 ton ha^{-1}, accompanied by an increase in pod weight $plant^{-1}$.

Response of pod weights of peanut plant on dolomites at cow manure dose at 20 ton ha^{-1} shows the pattern of negative quadratik response of regression equations y_{20}= -0.5833 x^3 + 7.1845 x^2 - 19.879 x + 23.68. The determination coefficient value of (R^2) of 0.8044. This indicates that only 80.44% of of the total variant of fixed variables of Y can be described by the function. Based on the estimate model then the applying of dolomite dose 0 tons ha^{-1} up to 1.76 tons ha^{-1} will reduce weight 7.76 grams of pods/plant, but increasing doses of the dolomites from 1.76 tons ha^{-1} up to 6.45 ton ha^{-1} increases weight of 37.68 grams of pods/plant. Further increase in the dose of dolomite 6.44 tons ha^{-1} up to 7.5 ton ha^{-1} reduce weights of 32.64 grams of pod/plant (Figure 1).

Peanut Plant can grow normally on the optimal soil pH ranged from 5.0-7.0. According to Nyakpa *et al*., (1998) the pH of the soil that is acidic will increases the solubility of Al, Mn and Fe which can inhibit the growth of plant roots so it interfere to the growth of the plant. The applying of the dolomites and cow manure can increase soil pH reached 6.40 so that soil pH is suitable for the growth and development of peanut plants. The increasing weight of the filled pod peanuts occur because of the availability of Ca in the soil which due to the applying of dolomite. Furthermore dolomite will

promote the development of pods of peanut plants. Based on the results of the analysis of the soil, the applying of dolomite and cow manure can increase the content of Ca soil up to 9.16 me/100 grams. The availability of Ca in soils with a sufficient amount led to the better development of pods and consequently the results of the pods will increase. In addition to dolomite role, adding manure also increase the weight of pods. According to Masum and Sudarsono (2003), that the addition of manure into the soil not only contribute nutrient elements to the crop can also improve the nature of the physical, chemical and biological soil. Peanuts require loose soil to be penetrated by gynophore easily so that the process of the formation of the pods did not experience barriers (Habiby *et al.*, 2013). The existence of a balance of roles between dolomites and cow manure causes a good growing media for peanut plants and finally increases pod weights of peanut plants.

Interactions influence of Dolomite and Cow Manure on Seed Weight per plant

Based on the results of the analysis of the orthogonal polynomial, seed weight per plant response on the dolomites at cow manure dose of 0 ton ha^{-1} shows the pattern of positive quadratic responses of regression equation with $y_0 = -0.5859x^2 + 6.0017 x + 9,951$. The value of the coefficient of determination (R^2) of 0.7035, this shows that only 70.35% of the total variant of Y fixed variables can be described by the function quadratic. Based on the estimate model then the optimum dolomite dose that is 5.12 ton ha^{-1} so that it will hopefully reach to a maximum average of seed weights plant^{-1} of 25.32 grams plant^{-1}.

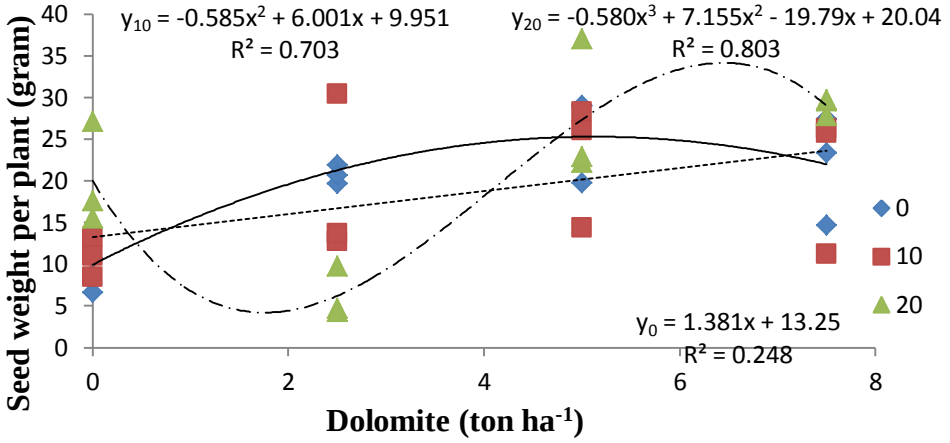

Figure 2. The interaction relationship of dose of dolomite and cow manure on seed weights per plant.

Response of seed weight plant^{-1} of peanut plants on dolomite at cow manure dose of 10 ton ha^{-1} shows the pattern of regression equations in linear response with y_{10}= 1.3816x + 13,251 (R^2 = 0.2481). Figure 2 shows that an increase in the applying of dolomite up to a dose of 7.5 tons at cow manure dose of 10 ton ha^{-1}, accompanied by an increase in seed weight per plant.

Response of pod weights of peanut plant at dolomites of cow manure dose of 20 ton ha^{-1} shows the pattern of regression equation with cubic response y_{20}= -0.5809 x^3 + 7.1552x^2 -19.791 x + 20.04. The determination coefficient value (R^2) of 0.4355, this shows that only 43.55% of the variant number of Y fixed variables can be described by the function quadratic. Based on the estimate model then supposedly applying dolomit dose of 0 ton ha^{-1} up to 1.76 tons ha^{-1} lowers the seed weight plant^{-1} of 4.2 g plant^{-1}, but increasing doses of the dolomites from 1.76 tons ha^{-1} up to 6.45 ton ha^{-1} increases the seed weight plant^{-1} of 34.19 grams plant^{-1}. Further increase in the dolomite dose of 6.45 ton ha^{-1} up to 7.5 ton ha^{-1} lower seed weight plant^{-1} of 29.02 grams plant^{-1}.

Applying of dolomites and cow manures can raise the pH of the soil which is initially at 4.40 becomes 6.40, 4.40 and increase content of Ca which is initially at 3.15 me/100 grams becomes 9.16 me/100 grams. This condition is pretty good for the growth and development of plant peanuts and condition of good soil will cause the plant roots well developed and be able to penetrate soil layers to get the nutrient elements. The period of formation of seeds is one of the critical phase of the plant. In this phase the plants require large amounts of nutrients to stimulate the growth and development of the perfect bean. Lack of nutrients causes the initiation process beans do not run perfectly, so that the yield is not optimal. Suntoro (2002) stated the addition of organic matter and the dolomites can improve availability of Ca and P. Hidayat (2008) stated that with increasing phosphorus supply in the plant will increase plant metabolism, which in turn will enhance the formation of seeds, so that the weight of the seeds will increase. This is in accordance with the opinion of Syafrina (2009) who stated that the function of phosphorus to plants is the stimulating generative growth such as formation of seeds.

Interaction influence of Dolomite and Cow Manure on the number of Unfilled Pods

Based on the analysis results of the orthogonal polynomial, the response of unfilled pod number of peanut plants on dose of dolomite and cow manure of 0 ton ha^{-1} shows the pattern of negative quadratic response with regression equations y_0 = 0.2827 x^2 –3.8427x+ 21,127. The value of the determination coefficient (R^2) of 0.8225, this shows that only 82.25% of

variant number of Y fixed variables can be described by the quadratic function.

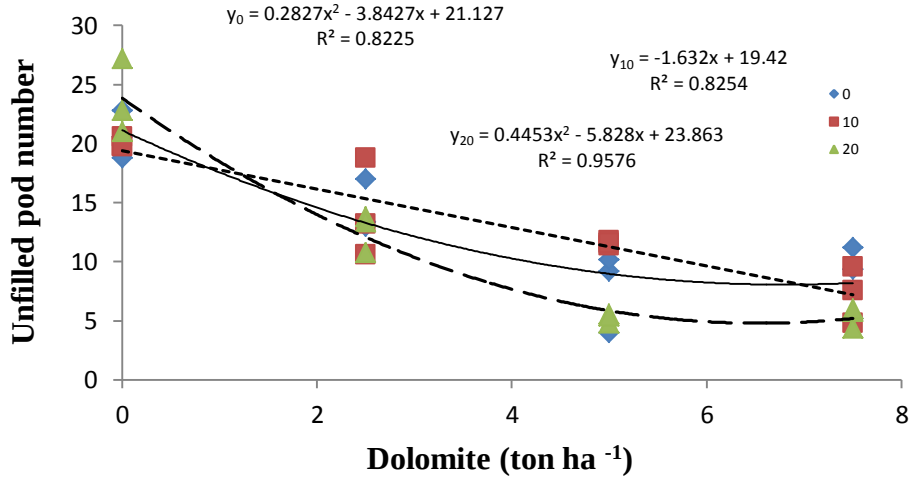

Figure 3. The interaction relationship of dolomite and cow manure dose on the number of unfilled pods

Based on the estimates model of optimum dolomite dose is 6.79 ton ha^{-1} so that it will hopefully reach the average minimum number of unfilled pods is 8.06 pods $plants^{-1}$.

Response of seed weight $plant^{-1}$ on dolomite dose at cow manure dose of 10 ton ha^{-1} shows the pattern of a linear response with regression equation y_{10} = -1.632x + 19 (R^2 = 0.8254). Figure 3 shows that the increase of dolomite dose up to 7.5 tons at cow manure dose of 10 ton ha^{-1}, accompanied by declining number of unfilled pods $plant^{-1}$.

Response of pod weight of peanut plant on dolomites at cow manure dose of 20 ton ha^{-1} shows the pattern of negative quadratic response with equation regression y_{20} = 0.4453 x^2 – 5.828x + 23,863. Determination coefficient value (R^2) of 0.9576, this shows that of 95.76% of the variant number of Y fixed variables can be described by the quadratic function. Based on the estimate model is supposedly optimum dose of dolomites is 6.54 ton ha^{-1} so that it will hopefully reach the average minimum number of unfilled pods is 4.79 pods $plant^{-1}$ (Figure 3). The combination dose of dolomite 0 ton ha^{-1} up to 6.54 tons ha^{-1} in applying cow manure 20 ton ha^{-1} resulted in decrease in the number of unfilled pods, but increasing doses of the dolomit 6.54 ton ha^{-1} to 7.5 ton ha^{-1} or higher does not increase the number of unfilled pods when compared with doses of dolomite 0 ton ha^{-1} which is average of 23.86 pods $plant^{-1}$.

The high number of unfilled pods is supposedly caused by ultisol soil without dolomite addition which has low nutrient availability. Yustisia *et al.,* (2005) stated seed plants that are grown on the soils that lack P causes reduced seed filling. This is in line with Osman (1996), P nutrient elements that are necessary for the process of formation of pods and seeds. Nutrient content is low during the formation of seeds can lower yield (Anidarfi *et al.,* 2010). The availability with a sufficient amount of P in soil leadS to the development of better seeds and pods, consequently the results of pods and seeds will increase. Whereas if the availability of P in the soil is low which will reduce yield of pods with increasing the number of unfilled pods of peanut plants.

The influence of dolomite dose alone on Number of root nodules

The results of the analysis of variants indicates that dose of dolomite alone realy effects on nodule numbers, pod weights, seed weights plant^{-1}, number of filled pods, number of unfilled pods, and 100 seed weights.

Based on the results of the analysis of the orthogonal polynomial, dolomite dose on number of root nodules to form patterns of positive quadratic response with regression equation is $y = -1.5378x^2 + 16.509x + 20.629$ ($R^2 = 0.2973$). Results from the equation, supposedly optimum dose dolomite is 5.36 ton ha^{-1} so that it will hopefully reach a average maximum number of nodules is 64.88 nodules plant^{-1}.

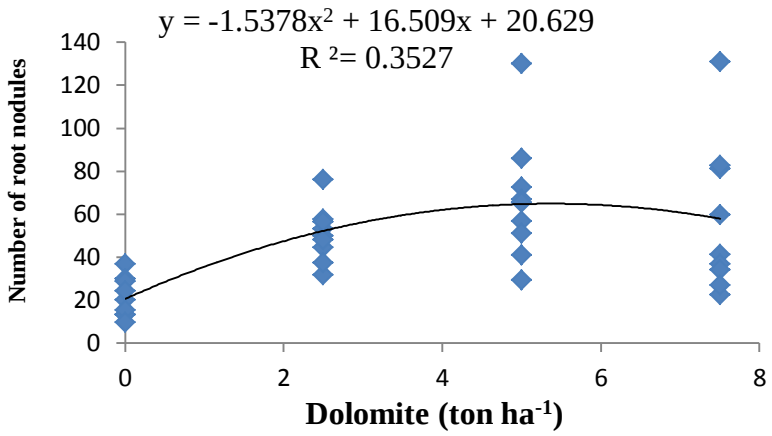

Figure 4. The relationship of the applying of various doses of the Dolomites on the number of root nodules.

Figure 4 shows that the increased dose of dolomite from a dose of 0 ton ha^{-1} up to 5.36 ton ha^{-1} can increase the nodule numbers, but increased doses of dolomite above 5.36 ton ha^{-1} are likely to decrease the nodule number. According to Silahooy (2012), the numbers of nodules was

strongly influenced by soil acidity, because acidic soil will affect the growth of *Rhizobium* SP. *Rhizobium* nodules which lived in the acidic soil will be less able to be formed. Rhizobium bacteria can grow well at a pH optimum of 5.5-7.0. Soil pH for activity of Rhizobium renders a number of nodules and more nodules will increased plant growth (Agistia *et al.*, 2006).

Noza *et al.*, (2014) stated that the applying of the dolomites can increase the soil pH and also the addition of organic matter on the acidic soil will increase the soil pH (Handoyo *et al.*, 2015). This statement is also supported by the results of the early and late analysis of soil suggest that an increase in soil pH from 4.40 increases to 6.40. According to Arimurti (2002) that the ability of Rhizobium in nitrogen from the air holds is influenced by the size and number of root nodules. The more nodules that form then the greater the nitrogen fixed by Rhizobium.

Number of Filled Pods

Based on the results of the analysis of the orthogonal polynomial, dolomite dose on the number of filled pods formed the pattern of linear response with equation regression is

$$y = 1.6596 x + 10{,}882 (R^2 = 0.4826).$$

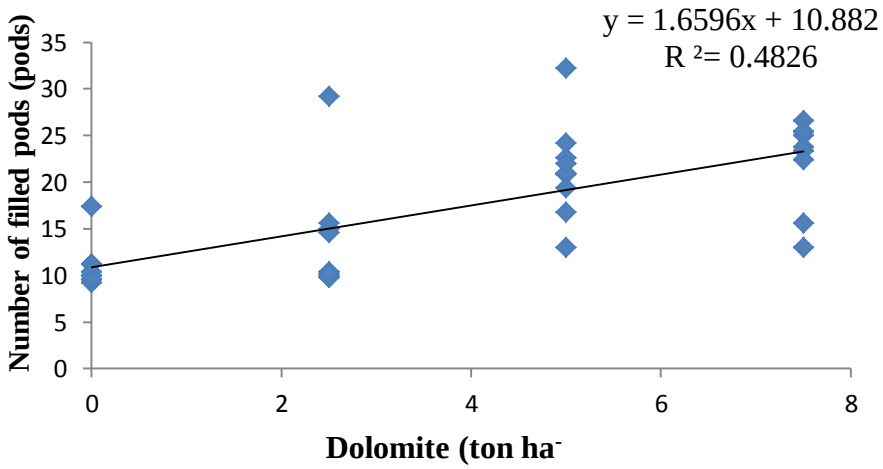

Figure 5. The relationship of various doses of the Dolomite on the number of filled pods

Figure 5 shows that an increase in dolomite application causes increasing number of filled pods and without dolomite results in 10.88 pods. Along with an increase in dose of dolomite is given response of peanut plants showed an increase in the number of filled pods. This happens probably the peanut plant responses on the addition of dolomite doses which is not yet reached the optimum value. Increasing number of filled pods of peanut plants lies on the content of the Ca in which is dolomite application. This agreed with Nyakpa, *et al.* (1998) stated that the addition of the content

of Ca in plant through liming needs to be done to obtain the maximum production. Based on the results of soil analysis of the beginning and end of an increase in content of Ca in soil. The content of the initial soil Ca is 3.15 me/100gram, and dolomite application is done once the manure happens an increased content of Ca i.e. 9.16 me/100 grams. The availability of Ca in soils with a sufficient amount of lead to the development of better seeds and pods and consequently the results of pods and seeds will increase. Elements of Ca for peanuts has an important role as a specific enzymatic reactions at activator in the formation of pods (Sari and Dewi, 2013). The addition of the content of Ca in soil has a good effect on the formation of the pods for making the peanut pods contain more filled.

Weight of 100 seeds

Weight of 100 seeds affected by seed size, either big or small. The larger the seed weight can contribute to higher yields, as well as vice versa. Based on the results of the analysis of the orthogonal polynomial of dolomite dose on the weight of 100 seeds to form a linear response patterns of $y = 1.0156 x + 31.383$ ($R^2 = 0.2554$).

Figure 6 shows that the increased dolomite dose accompanied by an increase in the percentage of weight of 100 seeds. The treatment of dolomite dose, along with an increase in dolomite dose peanut plants response is given showed an increase in the weight of 100 seeds are linearly, so that an increased dose of dolomite may still be carried out to obtain maximum results.

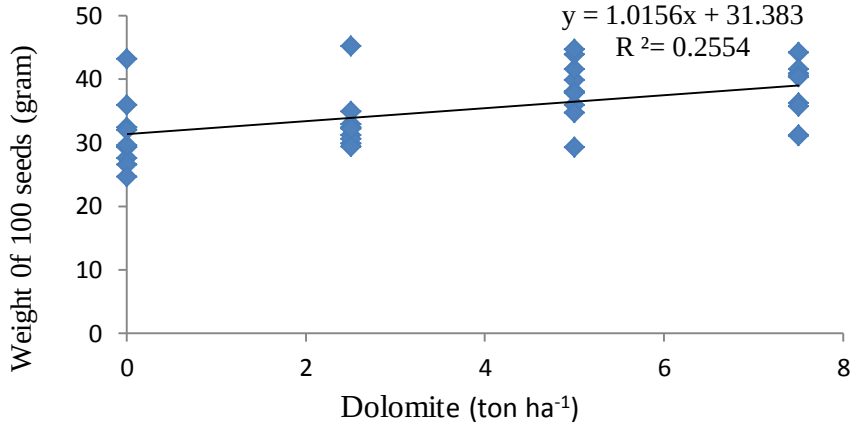

Figure 6. The relationship of the applying of various doses of Dolomites on 100 seeds weight.

According to Indria (2005) that the number and size of maximum seeds affected by genetic factors as well as environmental conditions at phase of seed fillings. A good cultivation conditions such as soil nutrient is

sufficient enough then it will be a maximum of plants in the formation of seed filling so that the size of the seed will be larger and heavier.

Effects of cow manure dose on peanut plants

Treatments of cow manure dose on research consists of three levels, namely that is 0 tons ha^{-1}, 10-ton ha^{-1} and 20-ton ha^{-1}. Based on the results of the analysis variant levels 5% showed that doses of manure as the single factor has no effect on all the independent variables of growth and yield of peanut plants.

Maesarah (2016), also reported that the treatment of cow manure with level 10 ton ha^{-1}, 20-ton ha^{-1} and 30 ton ha^{-1} has no effect on plant height, broad leaves, number of branches, plant fresh weight, root fresh weight, plant dry weight, dry root weights, number of pods $plant^{-1}$, number of nodules. This is supposedly due to nutrient content in cow manure has not been quite so available (Neltriana, 2015).

Conclusions

Doses of dolomites 6.45 tons ha^{-1} in applying cow manure 20 ton ha^{-1} weighting variables produce the pods highest peanut plants namely 37.68 grams/plant, seed weight per plant the highest i.e. 34.19 grams. Doses of amendments 7.5 ton ha^{-1} on applying cow manure 20 ton ha^{-1} produces minimum amounts of unfilled pods average 4.79 i.e. fruit/plant.Doses of dolomites 5.36 ton ha^{-1} is expected to reach the maximum number of variables rhizobia average i.e. 64.88 rhizobia/plant. Dolomite dosing on a peanut showed the higher dose of Dolomite is given then it is likely the higher the average number of pods pithy and weights 100 seeds plant peanuts.Applying cow manure with a dose of 0 to 20 ton ha^{-1} does give influence on the growth and yield of the plant peanuts.

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