Effectiveness of bio-slurry on the growth and production of soybean (Glycine max (L.) Merrill)

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Abstract. This research was aimed to determine the effectiveness of bio-slurry fertilizer on the growth and production of soybean plants which was conducted in the Pucak village, Tompobulu District, Maros Regency, South Sulawesi from July to October 2016. The research was set in randomized block design (RBD) with 8 treatments replicated three times. Treatment used were the application of bio-slurry consisted of 8 level of concentrations, namely: control (0 mL.liter⁻¹ of water), 3, 5, 7, 9, 11, 13 and 15 mL.liter⁻¹ of water. The variables measured were plant’s height, number of pods, weight of 100-seed, and soybean seeds’ yield per hectare. The results of research shows that the application of bio-slurry effectively improved growth and yield of soybean (pod’s number, 100-seed’s weight and seed yield per hectare). Optimal concentration of liquid bio-slurry to obtain maximum results were 9.27 mL.liter⁻¹ of water for the highest number of pods (68.49 pods); concentration of 8.75 mL.liter⁻¹ of water for heaviest weight of 100 grains (14.22 grams); and the concentration 8,12 mL.liter⁻¹ of water for the highest production of seed per hectare (23.20 quintal).

1. Introduction
Soybean (Glycine max L.) is one of national main beans’ commodities because it is the source of important phyto-protein for food’s diversification in contributing the national food’s tenacity. In fact, although soybean is Asia’s original plant, but ironically Asia’s countries become importers of soybeans from the outside Asia’s area. Indonesia includes on the prominent soybeans’ producer, but still imports seeds, soybeans residues after extracting its oil, and soybean’s oil. Nowadays, Indonesia very depends on import soybeans because the less production of soybeans.

The need of soybean in Indonesia reaches around 2.5 million ton per year, while the production of soybeans in country on 2015 only around 0.963 million ton, thus to fulfill the need, it was needed import. Strategy plan for Indonesia’s agriculture development is hoped to reach self-sufficient of soybeans on 2020 [1]. The government makes serious efforts to take down the dependence on import, thus soybeans include as one of three food’s commodities which is targeted can be self-sufficient beside rice and corn. The main problem is national production of soybeans lower rather than the need of country, thus it always experiences deficit. Therefore, without the efforts and special policy, the national need of soybeans will still depend on import. National productivity of soybeans only reaches 1.56 ton.ha⁻¹ with milling around 0.8 – 24 ton.ha⁻¹.
in the farmer’s level, while in the research level had achieved 1.7-3.2 ton.ha⁻¹, depends on the field condition and applied technology [2].

The consumption of soybeans leans to increase thus the import process is also increased. According to Subandi [3], there are 5 strategies which have to be conducted to assure the success of increasing soybeans’ national production namely amelioration of sale price; utilization of potential area; intensification of plantation process; amelioration of production process; and program consistency and tenacity of agriculture field officers.

Agriculture area which is generally available and used on plantation process of soybeans had been decreased in quality (degradation of land) that caused by utilizing of land resource without counterbalancing the land optimal restitution. The use of chemistry fertilizer continuously in great quantities is one of the degradation land’s causes. Supadma [4] stated that since 1984 the use of synthetic fertilizer by Indonesian farmer more and more increased to make maximal the agriculture yield obviously and fast. To solve that problem, society needs to be comprehended about the importance of agricultural system which friendly for environment and the use of organic fertilizer to increase the plant production. Organic fertilizer is the final result of changing or disentangling the remains of plant or animal, consists of almost all unsure such as; N, P, and K even Ca, Mg, and S, although the availability of those unsure usually in a bit quantities. P unsure in compost is almost excessively from dense feces, while N and K are from liquid feces [5].

One of organic fertilizer which can be used to increase the production of soybean plants is bio-slurry fertilizer. Bio-slurry or biogas waste is the product from the result of biogas processing of livestock feces and water through process without oxygen (anaerobic) inside of closed room. Bio-slurry fertilizer have excess such as; can improve the nature of soil physically, chemistry, and biologically and decrease the negative effect of making biogas such as; the smell, the environment contamination which can be the disease source. Bio-slurry also consists of probiotic microbe which is useful to increase the fertility and the health of agriculture land thus, it is hoped will affect on the increasing of yield’s quality and quantity [6].

The utilization of bio-slurry on plants should concern on the dosage and concentration. It is due to the possible unfavorable effects on plants when the concentration is too little or too much. Therefore, the selection of appropriate concentration needs investigation through this research [7].

2. Research Method
This research was conducted at Pucak village, Tompobulu subdistrict, Maros regency, South Sulawesi province from July to October 2016. The tools used were hand tractor, sprayer, mattock, gage, syringe, analytic weights and camera, while the materials are the soybean’s seeds of Anjasmoro’s variety and liquid bio-slurry.

The research was in form of experiment by using randomized block design (RBD), the treatment was the bio-slurry concentration (mL.litre⁻¹ of water) consisted of 8 levels i.e. 0, 3, 5, 7, 9, 11, 13, and 15. Each treatment was repeated 3 times.

The seeds of soybean were planted in plot 5 m x 4 m by using plant spacing of 25 cm x 25 cm. The treatment of liquid bio-slurry fertilizer was conducted 2 times, namely at 2 days after planting (DAP) and in the phase of 50% flowering.

The obtained data was then analyzed using software of SPSS ver. 23.0 and a further test using Duncan Multiple Range Test (DMRT). The selection of bio-slurry fertilizer’s optimal concentration was determined using regression analysis.

3. Results and Discussion
The result of statistical analysis showed that the treatment of liquid bio-slurry fertilizer was effective and could increase the growth and production of soybeans in some observed variables (p<0.05). This is because of bio-slurry will increase the availability of macro and micro nutrition unsure which are found on that
fertilizer and can be used maximally by soybean plants thus the growth, blooming, and production of plants will be more optimal. Liquid bio-slurry fertilizer is good because it contains various minerals needed by plants, such as; N, P, Mg, Ca, K, Cu, and Zn. Poerwowidodo in [8] stated that organic fertilizer contains N, P, and K thus will accelerate the process of amino acid and protein synthesis, so it will accelerate the growth of plants. Parwata et al. [9] stated that the giving of bio-slurry fertilizer can increase the growth of plants rather than without bio-slurry, because the plants can utilize nutrition unsure which are obtained from that bio-slurry to their growth optimally thus can give the maximal yield.

Table 1. the height of plants, the number of pods, the weight of 100-seeds and the production of soybean seeds’ yield per hectare on the various liquid bio-slurry concentration.

| Liquid Bio-slurry (mL.liter of water⁻¹) | Variables                  |
|----------------------------------------|----------------------------|
|                                        | Height of Plants (cm) | Number of Pods | Weight of 100-Seeds (gram) | Production of Seeds per Hectare (quintal) |
| 0 (B₀)                                 | 63.33 a                | 44.07 a        | 10.93 a                     | 11.36 a                                   |
| 3 (B₁)                                 | 61.83 a                | 51.40 ab       | 12.48 abc                   | 17.77 bc                                  |
| 5 (B₂)                                 | 54.50 a                | 58.00 b        | 13.26 bc                    | 20.57 c                                   |
| 7 (B₃)                                 | 62.33 a                | 71.53 cd       | 13.28 bc                    | 23.83 d                                   |
| 9 (B₄)                                 | 58.67 a                | 80.80 d        | 14.71 c                     | 25.58 d                                   |
| 11 (B₅)                                | 63.83 a                | 68.53 c        | 14.61 c                     | 19.92 c                                   |
| 13 (B₆)                                | 61.33 a                | 56.73 b        | 13.81 bc                    | 17.37 bc                                  |
| 15 (B₇)                                | 57.00 a                | 47.77 ab       | 11.74 ab                    | 15.75 b                                   |

Note: the number which was followed by similar alphabet means not significantly different on DMRT test level 0.05.

Sutresnawan et al. [10] stated that the giving of liquid bio-slurry fertilizer leans to produce the increasing number of leaves, and also the more great number of branch because in forming process of bio-slurry will occur fermentation in biogas waste which changes food substance to be available for plants so, it makes easier the absorption of nutrition unsure that finally can increase the growth and production of plants. N Unsure in liquid bio-slurry more excessive and easy to be absorbed by plants thus can increase the growth of plants.

The result of DRMT test on table 1 shows that the effectiveness of liquid bio-slurry was seen from the highest result of greatest pods’ number (80.80 pods) which were found in the giving of liquid bio-slurry on the concentration 11 mL.liter⁻¹ of water but on the variable the weight of 100-seeds and production seeds per hectare precisely the highest result (14.71 gram and 25.58 quintal) are on the concentration 9 mL.liter⁻¹ of water. This shows that the need of soybean in kicking the growth of pods and the development of seeds needs liquid bio-slurry on the concentration 9-11 mL.liter⁻¹ of water. Nitrogen of liquid bio-slurry on that concentration affects the growth and increases the number of pods, the weight of 100-seeds and production of seeds per hectare.

The higher concentration of liquid bio-slurry which is given on soybean plants then the forming and growth of pods and seeds of soybean more increased because soybean plants are able to utilize those nutrition unsure to their generative growth optimally so can give the maximal result, but if the concentration was increased more than 11 mL.liter⁻¹ of water, in fact the soybean plants decreased in the growth rapid of
100-seeds’ weight and production of seeds per hectare. This is caused by the concentration (11-15 mL.liter⁻¹ of water) soybean plants gets excess where actually the excess is not needed again by them.

The content of phosphor unsure on bio-slurry fertilizer influences toward the growth of flowers and pods of soybean plants. This is suitable with the analysis result of bio-slurry unsure which shown that bio-slurry fertilizer contains higher C-organic No.28/Permentan/OT.140/2/2009 that is bigger than 12, and also the content of nitrogen, phospor, potassium nutrition which are appropriate with quality standard of organic fertilizer that is under 6%. The higher concentration of bio-slurry which is given to soybean plants then the greater of available nutrition unsure supplement and can be absorbed by the plants thus the greater photosynthesis’ results which are resulted to be transferred further into pods, the filling and growing of soybean seeds which finally increase the production of soybean seeds [11].

The result of regression analysis shows that there are real positive relation between bio-slurry concentration with the number of pods and have quadratic characteristic where the equation is

\[ y = -0.3483x^2 + 6.459x + 38.548 \]

\[ R^2 = 0.606 \]

Based on that equation, the optimum concentration of bio-slurry fertilizer is 9.27 mL.liter⁻¹ of water which resulted maximal pods around 68.49 pods. The similar condition also occurred between bio-slurry concentration with the weight of 100-seeds and seeds’ production that both have quadratic characteristic

\[ y = -0.0474x^2 + 0.8295x + 10.589 \]

\[ R^2 = 0.830 \]

\[ y = -0.1806x^2 + 2.9316x + 11.3 \]

\[ R^2 = 0.890 \]

so optimum concentration of bio-slurry fertilizer is 8.75 mL.liter⁻¹ of water to produce maximum weight of 100-seeds around 14.22 g, while on the variable of production seeds per hectare, the optimum concentration is 8.12 mL.liter⁻¹ of water to produce 23.20 quintal. Based on those three variables was known that optimal concentration of bio-slurry for soybeans is 8.12 – 9.27 mL.liter⁻¹ of water. The content of the higher N, P, and K unsure on bio-slurry will stimulate the generative growth on soybean plants thus able to accelerate and increase the form of flowers, pods, and seeds. The high of N unsure on bio-slurry fertilizer influences to the increasing of N unsure at the soil thus it will be also absorbed more excessive. Maspray [12] stated that liquid organic fertilizer contains the high N and K unsure and also the growth stimulating substance such as IAA. Furthermore, Nur, Erlina and Nasih (2007) suggested that liquid bio-slurry is applied through leaves thus it fast to be used by soybean plants. This fertilizer can increase the forming of soybeans’ leaves chlorophyll and root nodule until the plant’s ability more increases to fixate the air of N and to do photosynthesis. Besides that, bio-slurry can improve the nature of soil physically,
chemistry and biologically, increase the quantity and quality of production, and also decrease the use of inorganic fertilizer [13].

4. Conclusion
- Liquid bio-slurry is effective to increase the growth and production of soybean plants (the number of pods, the weight of 100-seeds and production of seeds per hectare).
- The optimal concentration of liquid bio-slurry to obtain maximal yield were 9.27 mL-liter⁻¹ of water to the greatest number of pods (68.49 pods); concentration 8.75 mL-liter⁻¹ of water to the heavier weight of 100-seeds (14.22 g); concentration 8.12 mL-liter⁻¹ of water to the higher production seeds per hectare (23.20 quintal).

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