Utilization of liquid organic fertilizers from banana stems and coconut husk to increase potassium (K) in alfisols and corn

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Abstract. The needs of plant potassium can be done by adding banana stem liquid organic fertilizer and coconut husk liquid organic fertilizer containing many K elements. This study aims to determine the increase in nutrient potassium and its effect on the growth of corn of Alfisols. The research design was a split-plot design consisting of the main plot as banana stem liquid organic fertilizer (P1) and coconut husk liquid organic fertilizer (P2). The sub-plots were d0 (0 ml), d2 (75 ml), d1 (50 ml), d3 (100 ml) obtained eight treatment combinations and repeated three times. Liquid organic fertilizer from banana stems and coconut husk can increase the availability of K in the soil. Coconut husk liquid organic fertilizer with 100 ml dose significantly affects the increase in pH, C-organic, Cation Exchange Capacity (CEC), availability of sodium, and exchangeable calcium. Also, it shows the highest average in increasing plant height and plant dry weight. The application of coconut husk liquid organic fertilizer significantly affects K content in plants and plant height. However, it has no effect on the dose given.

1. Introduction
Potassium (K) is an essential nutrient for plants after nitrogen (N) and phosphorus (P). K is needed in almost all plant growth processes and various plant physiological functions. In general, K has a function in increasing the growth of meristem tissue, strengthening the upright stems, and helping plant roots [1]. K availability in the soil is strongly influenced by pH and base-saturation (BS). At low soil pH and low BS, K will quickly disappear because they are susceptible to losses [2]. One of the soil orders that has a low soil pH and KB is Alfisol. This soil is also very poor in K nutrients, so the addition of liquid organic fertilizer, which is rich in K nutrient sources, is a way to meet the nutrient needs of the cultivated plant on the soil [3].

One of the efforts to supply K demands for plants is by utilizing natural materials such as banana stems and coconut husks as fertilizers. Banana stems are agricultural waste containing potential compounds such as K, P, iron (Fe) [4], and N [5]. In addition, coconut husk has a lot of macro and micronutrients such as N (0.28 ppm), K (6.726 ppm), Ca (140 ppm), and Mg (170 ppm) [6]. Therefore, these two materials support K's demands for plants while applying as liquid organic fertilizer.

Based on the explanation above, this research was conducted to identify the effect of liquid organic fertilizer application from banana stems and coconut husks to increase K elements in the soil.
2. Methodology

2.1. Time and place
This research was conducted from October 2019 to June 2020 in the Experimental Farm of the Faculty of Agriculture, Hasanuddin University. Soil sample analysis was carried out at the Laboratory of Soil Fertility Chemistry, Department of Soil Science, Faculty of Agriculture, Hasanuddin University. Furthermore, the location of soil sampling is at Experimental Farm, Faculty of Agriculture, Hasanuddin University.

2.2. Research methods
This research was conducted in an experimental form based on a split-plot design (RPT). Type of liquid organic fertilizer (p) as the main plot, namely (p1) liquid organic fertilizer from banana stems and (p2) from coconut husk, while the dosage of liquid organic fertilizer (d) as subplots were (d0) 0 ml, (d1) 50 ml, (d2) 75 ml and (d3) 100 ml. In total, this study had eight treatment combinations.

2.3. Research flow
This research went through two stages, namely the initial analysis and the final analysis. A literature study was carried out in the initial analysis stage, making Liquid organic fertilizer, site surveying, and sampling of disturbed soil. After that, the final analysis stage, planting, liquid organic fertilizer application, sample analysis, and conclusion stage were carried out.

2.4. POC preparation
The stages of making Liquid organic fertilizer of banana stem and coconut husk are to prepare 5 kg of the two ingredients then mix them into 15 l of water. 500 g brown sugar and 250 ml EM4 were added and then fermented for 14 days before it was ready for use in the field.

2.5. Preparation for planting
The preparatory stages for planting include tillage, which is done by loosening the soil and then making soil-beds with a size of 100x200 cm and a height of 20 cm with a distance between the soil-beds of 50 cm and a distance between replications was 100 cm. The cultivated land is planted with Bima-19 corn seeds. Corn seeds are planted 3-5 cm deep with two seeds per hole.

2.6. Parameters Observation
The parameters were focused on the two aspects, namely: 1) soil properties; pH, soil organic C, Cation Exchange Capacity (CEC), available K, available P, total N, Cation bases (Ca, Mg, Na), and 2) Plant parameters were carried out by measuring plant height, number of leaves, plant dry weight, root dry weight, ear weight without husks, dry weight of 1,000 corn kernels and analysis of plant K content.

3. Results and Discussion

3.1. Analysis results of liquid organic fertilizers
The liquid organic fertilizer (POC) from banana stems and coconut husk contains a lot of K elements (table 1), as in [7] proves that the liquid organic fertilizer from coconut husk and banana stems contain K.

| POC analysis       | K (%) | C-Organic (%) | P₂O₅ (ppm) | N-total (%) |
|--------------------|-------|---------------|------------|-------------|
| Banana stem (BP)   | 2.63  | 1.43          | 38.87      | 0.39        |
| Coconut husk (SK)  | 3.45  | 1.63          | 84.88      | 0.47        |
3.2. Results of soil analysis before treatment

Intensively cultivated soil without preservation efforts can reduce soil chemical fertility or low nutrient availability in the soil (table 2), as explained by [8-9], which states that intensive preparation can negatively impact the soil, such as structural damage to soil moisture and nutrients. [10] said that organic matter could also decrease if the tillage system is carried out continuously.

| Soil chemical properties                      | Score       | Criteria |
|-----------------------------------------------|-------------|----------|
| C-Organic                                     | 1.16%       | Low      |
| Cation Exchange Capacity (CEC)                | 16.43 cmol / kg | Low     |
| Available K                                   | 0.16 cmol / kg | Low     |
| N-Total                                       | 0.07%       | Very low |
| pH                                            | 5.5         | Acid     |

3.3. Result of soil analysis after treatment

3.3.1. Potassium (K). There was no decrease in soil K (figure 1). This is because the CEC strongly influences the availability of K. The greater CEC, the greater the ability of the soil to hold K, which then slows the release of K and reduces the potential for leaching [10]. The POC treatment from banana stems (d2) in Figure 1 has a higher yield than coconut husk POC. This is because banana stems have a pH that tends to be neutral and can make K bounded by Ca [12].

3.3.2. Soil pH. Based on the soil analysis results, there was no significant effect on soil pH, but there was an increase in all treatments that occurred due to the application of basic fertilizers (figure 2). Whereas a high increase in the POC treatment from banana stems (p1d2), as stated by [13], banana stems can be used as a source of alkaline, which can stabilize soil pH in an acid condition.

3.3.3. C-Organic soil. The C-Organic content after treatment has increased, yet not significant. Table 3 shows that there was an increase with the increasing dose of POC given. The increase in C-Organic can
be caused by POC, a source of C content for the soil. This can occur because the C-Organic content of the soil can be influenced by external factors such as rainfall, soil type, temperature, the input of organic matter from aboveground biomass, anthropogenic processes, soil management activities, and atmospheric CO₂ content [14].

Table 3. Soil organic C content after treatment.

| p    | d     | Average |
|------|-------|---------|
|      | d0    | d1      | d2    | d3    |
| p1   | 2.08cp| 2.10bcp | 2.12bp| 2.22ap| 2.13   |
| p2   | 1.68cp| 1.68cq  | 1.77bp| 1.90ap| 1.76   |
| Average| 1.88  | 1.89    | 1.95  | 2.06  |

Noted: p1: POC from banana stem, p2: POC from coconut husk, d0: 0 ml, d1: 50 ml, d2: 75 ml, d3: 100 ml. Description: p1: POC from banana stem, p2: POC from coconut husk, d0: 0 ml, d1: 50 ml, d2: 75 ml, d3: 100 ml. The alphabet abcd was significantly different in the treatment with liquid organic fertilizer, pqrs was significantly different at the given dose.

3.3.4. Cation exchange capacity (CEC). The results of the soil CEC analysis increased because POC has chemical benefits (table 4); for example, it can produce humic compounds that contribute to colloids with negative charges [15]. According to [1], the higher the organic matter content of a soil, the higher the CEC value because the organic matter has large cation-absorbing power.

Table 4. Soil CEC after treatment.

| p    | d     | Average |
|------|-------|---------|
|      | d0    | d1      | d2    | d3    |
| p1   | 18.87cq| 24.21bp | 20.92bcq| 27.98ap| 23.00   |
| p2   | 22.23bp| 26.65ap | 25.52abp| 25.85ap| 25.06   |
| Average| 20.55  | 25.43    | 23.22  | 26.91  |

Noted: p1: POC from banana stem, p2: POC from coconut husk, d0: 0 ml, d1: 50 ml, d2: 75 ml, d3: 100 ml. The alphabet abcd was significantly different in the treatment with liquid organic fertilizer, pqrs was significantly different at the given dose.

3.3.5. N-Total. The POC analysis results showed that N content in the soil treated with coconut husk POC was higher than the soil with the POC from banana stems (table 5). However, after treatment, the soil follow-up test results found that banana stem POC had a significant effect on increasing N-total. This is in accordance with the study from [14], explained that there are three main sources of soil N, namely (1) soil organic matter, (2) N tethered from free air by legume plants which are symbiotic with rhizobium bacteria and (3) ) of inorganic fertilizers. The weathering of organic matter in the tropics is very fast, resulting in N, which is also quickly released in inorganic N, which is easily available to plants.

Table 5. N-total soil after treatment.

| p    | d     | Average |
|------|-------|---------|
|      | d0    | d1      | d2    | d3    |
| p1   | 0.16  | 0.19    | 0.19  | 0.18  | 0.18a  |
| p2   | 0.12  | 0.11    | 0.17  | 0.20  | 0.15b  |
| Average| 0.14  | 0.15    | 0.18  | 0.19  |

Description: p1: POC from banana stem, p2: POC from coconut husk, d0: 0 ml, d1: 50 ml, d2: 75 ml, d3: 100 ml.
3.4. Corn plant growth

3.4.1. Plant height. The highest plant height from coconut husk fertilizer (table 6). Provision of coconut husk POC on the soil can add and supply the complete nutrient content needed by corn plants. From the results of POC analysis, coconut husk contains macronutrients N, P, and K, which are very necessary for plant growth. This is in accordance with [16] explained that N content is useful to help stimulate plant growth, especially vegetative growth such as green leaves through the synthesis of amino acids and proteins in plant organs.

Table 6. Plant height.

| P    | d  | Average |
|------|----|---------|
|      | d0 | d1     | d2     | d3  |         |
| p1   | 92.77 | 101.04 | 98.29  | 88.58 | 95.17b   |
| p2   | 95.56 | 98.42  | 101.98 | 104.81 | 100.19a  |
| Average | 94.17 | 99.73  | 100.14 | 96.70  |

Description: p1: POC from banana stem, p2: POC from coconut husk, d0: 0 ml, d1: 50 ml, d2: 75 ml, d3: 100 ml.

3.4.2. Number of leaves. Giving POC provides a more effective effect on plant growth because this type is easily absorbed by plants (table 7). According to the study by [17], applying POC to the soil will make the root system of the soil develop more completely, absorb greater nutrients and improve plant growth.

Table 7. The number of leaves.

| P    | d  | Average |
|------|----|---------|
|      | d0 | d1     | d2     | d3  |         |
| p1   | 10.96 | 11.31  | 10.98  | 10.58 | 10.96b   |
| p2   | 11.00 | 11.75  | 11.50  | 11.33 | 11.40a   |
| Average | 10.98 | 11.53  | 11.24  | 10.96  |

Description: p1: POC from banana stem, p2: POC from coconut husk, d0: 0 ml, d1: 50 ml, d2: 75 ml, d3: 100 ml.

3.4.3. Plant Potassium (K) Levels. Based on the results of plant nutrient analysis, it was found that the POC content in plant tissue was correlated with the amount of K content in coconut husk POC (table 8). The amount of K in the soil after the addition of POC increased so that by applying several times fertilization and increasing the dose was able to supply K nutrients. For the corn crop. The higher the potassium concentration in the soil, the higher the K content in plants [18].

Table 8. Plant K levels.

| P    | d  | Average |
|------|----|---------|
|      | d0 | d1     | d2     | d3  |         |
| p1   | 2.58 | 2.75   | 2.84   | 2.81 | 2.75b    |
| p2   | 2.93 | 2.94   | 3.06   | 3.04 | 2.99a    |
| Average | 2.75 | 2.85   | 2.95   | 2.92  |

Description: p1: POC from banana stem, p2: POC from coconut husk, d0: 0 ml, d1: 50 ml, d2: 75 ml, d3: 100 ml.
4. Conclusion
Coconut husk's liquid organic fertilizer significantly affects the increasing K level in the soil, plant height, and leaf numbers. However, the increase in K did not significantly affect by the doses given. But, banana stem liquid organic fertilizer on 75 ml showed the highest increase in K level in the soil among all treatments.

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