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The potential of treated human manure and urine as fertilizer on maize (*zea mays* L.)

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Utilization of feces and urine as soil fertilizer are an effective solution for lands with limited resources and difficultly to obtain agricultural inputs. The aims of the study is to determine the potential of feces and urine as a source of nutrients in Maize crops. This research has been conducted on May to September 2017 at field as the Academicals Business Unit Agro Techno Park, Brawijaya University, Jatikerto, Kromengan-Malang. This research used experimental of factorial with randomized block design with 7 treatments and 3 replication. The utilization of fertilizers derived from feces and urine potential to use for increasing corn production due to provide the same results with of common organic fertilizers such as goat manure and chemical fertilizer. In Maize yields it is seen that the use of both solid and liquid fertilizers derived from human waste (feces and urine) and inorganic fertilizers showed no different results. This means that when compared to the control of Treatment 1, treatment 2 to 7 gives the same yield on Maize crops, so that the plant requires fertilizer as a nutritional requirement.

Keywords: treated human manure, treated urine, corn production

INTRODUCTION

Maize (*Zea mays* L.) is a cereal crop which is common cultivated in the dry area of Indonesia, hence still having difficulties to increase the yield. The low yield of Maize are mainly the result of poor land management and sub optimal plant growth, factors like inadequate fertilization, less fertile land conditions and the lack of additional organic fertilizers can lead to degradation of soil biological fertility. The application of organic matter to the soil can improve soil fertility. Organic fertilizer, have some advantages over inorganic fertilizers, factors like gradual release of nutrients and many other ingredients that can improve soil fertility, whereas inorganic fertilizers contain only one or more nutrients, which are immediately decomposed on the ground, and immediately available to plants, so that little residue is left on the ground (Lidiawati and Handayanto., 2002).

Human feces or stools become one of the alternatives that are still not ogled society, to be a raw material of quality organic fertilizer. Human waste is considered as a source of value able nutrients in a number of countries, for example in China, Japan, and Korea. The existence of waste and household waste must be understood by the community as a resource that can generate economic benefits, as well as good for the environment. Human waste is a valuable source of nutrients; therefore it needs to be developed to replace some of the artificial fertilizers used (Jonsson et al., 2004).

Utilization of feces as fertilizer even been started since 1908 in China. At that time, the Shanghai City Council sold the right to collect feces to a Chinese businessman for 31,000 pieces of gold. 78,000 tons of stools are collected with special procedures, to be brought to the

countryside and sold as fertilizer for farmers. The use of feces also occurred in Japan at that time. The total amount applied in all Japanese agricultural lands reaches even 23,850,295 tons or an average of 1.75 tons per 4,000 square meters of land (Drangert, 1998). In addition to human waste, human urine can also be used as a good organic fertilizer for soil fertility. Human urine is a valuable resource, but it is underutilized for the cultivation of crops that have been used in agriculture since ancient times, at least in intensive farming systems in different parts of Asia Kirchmann and Pettersson (1995).

The objectives of this research is to see the potential of treated human manure and urine as a substitution to chemical and other organic fertilizer.

MATERIALS AND METHODS

This research was conducted in May until September 2016. The research was conducted in academic business unit of Agro Techno Park Universitas Brawijaya that located in Garden of Jatikerto, Kromengan District, Malang Regency, East Java. The experiment used randomized group design (RGD) with 7 treatments and 3 Replications (three), The treatments include Treatment 1 = Control (soil only); Treatment 2 = 100% pure urine; Treatment 3 = 50% pure urine and 50% feces compost; Treatment 4 = 50% pure urine, 50% feces compress and Plant Growth Promoting Rhizobacteria (PGPR); Treatment 5 = Inorganic Fertilizer (Urea 50% and Phonska 50%); Treatment 6 = Inorganic Fertilizer (Urea 25% and Phonska 25%) and 50% goat manure; Treatment 7 = Inorganic Fertilizer (Urea 25% and Phonska 25%), 50% goat manure and PGPR (Plant Growth Promoting Rhizobacteria).

Observations were performed at the ages of 2 to 14 weeks after planting. The variables are: (a) Plant height, (b) Leaf area, (c) Index of chlorophyll (d) Productivity. Data were analyzed of variance (ANOVA). Further analysis of the least significant difference (LSD) at the level of 5%.

RESULTS AND DISCUSSION

The vegetative growth of Maize associated with the addition of size and the number of cells in a plant. The growth of Maize include germination phase followed by a phase of vegetative growth that includes enlarged stems, leaves and roots of plants which slows down when it starts generative phase. The results of the study in Pic. 1A showed the results on the plants treated with the treatment showed a real difference in every age of observation.

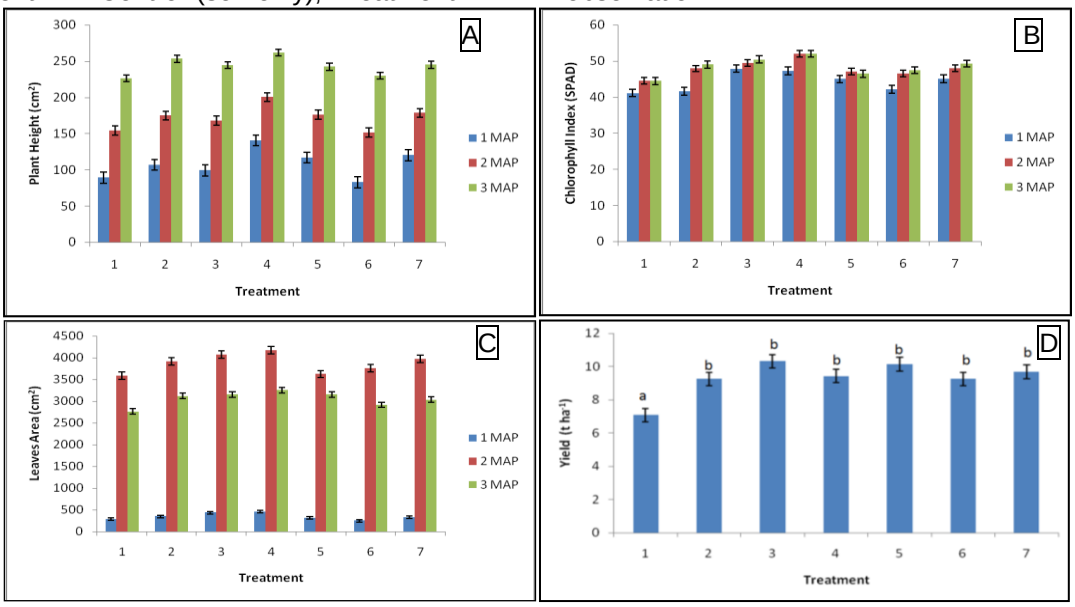

Figure 1. Human Manure and Urine as Fertilizer on Plant Height (A); Chlorophyll Index (B); Leaves Area (C) and Yield (D)

Information: Treatment 1: Control (only soil); 2: 100% pure urine; 3: 50% pure urine and 50% feces compost; 4: 50% pure urine, 50% feces compress and PGPR; 5: Inorganic Fertilizer (Urea 50% and Phonska 50%); 6: Inorganic Fertilizer (Urea 25% and Phonska 25%) and 50% goat manure; 7: Inorganic Fertilizer (Urea 25% and Phonska 25%), 50% goat manure and PGPR

At 2 DAP observation, Treatment 1 as the control is not different with Treatment 2, Treatment 3 and Treatment 6. While the observation Treatment 4 has the highest value of 262.00 cm. In the study, the plant height observation shows similar trend until the end of vegetative phase.

Based on the results of research on chlorophyll index parameter in get significantly different results at the age of 1 to 3 MAP (Pic. 1B). The result of leaf area study (Pic. 1C), showed the effect of treatment that caused different leaf area. At the age of 1 month after planting obtained results range 250.84 cm^2 to 456.02 cm^2. Best influence on treatment, Treatment 4 are 456.02 cm^2 but not significantly different from Treatment 3 is 437.66 cm^2. At the age of 2 month after planting the range of values is 2583.95 cm^2 to 4168.62 cm^2. At age 3 month after planting the range of values is 2763.19 cm^2 to 3252.05 cm^2.

The results showed that with the same total N supply Maize crop productivity gains that have outcomes that are not much different (Pic. 1B). In the control condition (Treatment 1) has the lowest yield of 7.07 t ha^{-1}. The results of Treatment 2 to Treatment 7 have no significant different results that range from productivity values of 9.24 t ha^{-1} to 10.31 t ha^{-1}. From the figure it can be seen that with the same total nutrient supply the difference between the use of organic fertilizer (manure) and inorganic fertilizer has a result that is not much different. The content of organic fertilizers is more complex than inorganic but the availability of nutrients capability of being absorbed by plants is higher in inorganic fertilizers as well as we know that the content of inorganic fertilizers is high mobility.

DISCUSSION

This study basically compares the growth and yield of maize by using organic manure and inorganic fertilizer which is commonly used by farmers, each fertilizer has Nitrogen content which is supplied with the same amount based on the calculation. The study of fertilizer calculation is only based on Nitrogen content; basically for plant growth requires micro or macro nutrients. Inorganic fertilizers have lower yields can be seen that specific inorganic fertilizers to nutrient content than organic fertilizers derived from human waste both in the form of urine and stools that have a more complex nutrient content. This time, the public in general still assume that feces and urine produced from the human body's digestive process is the dirt that must be removed. Many ways to do like throwing directly into the river, making septic tanks and build the wastewater treatment plant (WWTP). In this way, it is expected feces and urine will not pollute the water and soil, and does not harm human health Widowati et al., (2007).

Like another plants, maize also requires nutrients for its survival. The nutrient elements consist of C, H, O, N, P, K, Ca, Mg, S, Fe, B, Cu, Zn, Mo, Mn, Cl, Si, Na, and Co. The nutrient element is derived from the rocks in the soil Guandarrama et al., (2001). However, the ability of soil to provide nutrients for plants is very limited due to the micro-organisms that play a role in the weathering process the amount differs between species and soil layers to one another. Therefore, fertilization is one way to provide nutrients needed by plants (Ekowati and Nasir, 2011).

Organic fertilizers play a role in influencing the physical, chemical and biological properties of the soil. Organic fertilizers can improve the physical properties of the soil through the formation of structures and aggregates of soil and are closely related to ability of the soil to bind water, infiltrate water, reduce the threat of erosion, increase ion exchange capacity (CEC) and as a temperature regulator all of which affected plant growth Kononova 1999; Foth, (1990). Organic fertilizer contains nutrients that are indispensable for the growth Tandisau and. The use of organic extract (organic liquid fertilizer) with a concentration of 2-3 ml l^{-1} of water can increase the yield of various plants, such as chili, tomato, and Maize up to about 25% (Simarmata, 2005).

In this research seen the best influence of Treatment 4 on the growth of Maize crops. One of the parameter that can be used as an indicator of leaf area. Extent in cultivation of crops associated with growth and development of plants (Peksen, 2007) and may indicate or refer to the production and productivity of plant yields The leaf area is important for determining the capacity of the plant to synthesize and translocate photo assimilates to several organs of the plant (Rivera et al., 2002).

In Maize yields it is seen that the use of both solid and liquid fertilizers derived from human waste (feces and urine) and inorganic fertilizers showed no different results. This means that when compared to the control of Treatment 1, treatment Treatment 2 to 7 gives the same yield on Maize crops, so that the plant requires fertilizer as a nutritional requirement. Fertilization can increase Maize yields both qualitative and quantitative. In addition Organic fertilizer can replace or reduce the use of inorganic fertilizer continuously

because it can damage the physical, chemical and biological properties of the soil. As Suliasih et al., (2011) notes, that organic matter in soil plays an important role in improving the physical, chemical, and biological properties of the soil so as to maintain and improve soil fertility, and reduce dependence on inorganic fertilizers.

The results of Rodhe et al., (2004) explains that in human waste, the mixture of feces and urine contains many nutrients needed by plants such as N, K, Mg and Ca. When composted then the waste of urine and feces will increase the content of the elements contained therein. Compost has the macro and micro nutrients that plants need for growth and production, as well as improving the physical soil such as soil structure, soil texture, aerase and soil drainage, soil temperature, enhancing the soil bonding capacity to nutrients, and can improve the life of microorganisms in the soil (Afitin and Darmanti, 2009).

Feces and urine that are regarded as useless dirt, apparently contain nutrients very much. With the high content of N, P and K elements, urine has a high potential for use as fertilizer. According to Jonsson et al., (2005), one liter of urine can be used to fertilize about one square meter, and with the volume of urine in one year is estimated to be used to fertilize about 300-400 m^2 of agricultural land.

Every day, human waste discharged contains 90 g of organic material (in the form of 30 g of carbon), 10 -12 g of nitrogen, 2 g of phosphorus and potassium 3g Rodhe et al., (2004). According to Morgan (2003), one liter of urine contains about 11 g of nitrogen, 0.8 g phosphorus and 2 g of potassium or with an elemental ratio of N: P: K is 11: 1: 2. When 500 L of urine is produced by one person within a year, it is estimated that the amount of NPK is 5.6 kg nitrogen, 0.4 kg phosphorous and 1 kg of potassium. Research *Widowati* et al., (2007) obtained the use of fertilizer from feces of 15 t ha^{-1} can produce production in optimum pepper plant.

CONCLUSION

The results showed that human waste potentially used as a source of organic fertilizer. The results showed that the use of fertilizers sourced from human waste has a potential yield that is not different from the use of inorganic fertilizers shown by the productivity of 9.24-10.31 t ha^{-1}.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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