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Short-Term Effect of China Violet Compost on Soil Properties of Ultisol and Peanut Yield

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***Abstract*— Compost application can contribute to agricultural sustaniability that it has proven to improve soil quality and crops yield. One of the ingredients can be made of china violet that mostly found as weeds in oil palm and rubber plantation. The aims of this study were to evaluate the effect of compost application on soil properties of Ultisol and peanut yield. The experiment was carried out at the Experimental Field of Agriculture Faculty, University of Jambi, Mendalo Darat, Jambi. The treatments were arranged in a rondomly blocked design consisting of (i) control (without compost), (ii) 5 Mg ha-1 compost, (iii) 10 Mg ha-1 compost, (iv) 15 Mg ha-1 compost, and (v) 20 Mg ha-1 compost. The results of study showed that the application of compost improve the soil chemical properties by increasing soil pH, CEC, N, P, and K. In addition peanut yield was increased by compost application. The highest increase in peanut yield was achieved by application of 20 Mg ha-1 compost.**

***Keywords*— Sustainability; Compost; Soil Properties; Ultisol; Peanut**

I. INTRODUCTION

Peanut (*Arachis hypogaea* (L.) Merr.) is one of the most important pulse crops grown in Indonesia besides soybean (*Glycine max* (L.) Merr.). However, the production of peanut from 2007-2011 fluctuates with average 758,632 Mg year^{-1} and the average yield 1,23 Mg ha^{-1} so that it has to be imported 251,748 Mg in 2011 [1] . The problem is not only low of average yield but also low of harvested area.

To increase production and average yield of peanut it can do through both the expansion of harvested area (extensification) and increase the utilization of existing arable land (intensification). However, fertile arable land has been converted to other utilization so that the expansion of arable land turned to marginal drylands. One of the potential dryland to be developed is Ultisol. But the main problem in developing dryland farming in Ultisol is the limitation of soil physical dan chemical properties.

One one of efforts to improve the productivity of Ultisol is the application of organic matter. Application of organic matter incerases the soil organic matter (SOM) status in the top soil. SOM has multiple beneficial effects on water holding capacity, aeration, permeability, soil fertility, crop production and overall soil sustainability [2], [3], [4].

In the last decade, the application of wastes with a high organic matter content to soil has been performed in an effort to supply plant nutrients at a reduced cost and to maintain soil organic matter levels, such as animal manure [5], [6], compost, [7], [8], [9], crop residues [10], [11], green manure [12], industrial by-products [13], and sewage sludge [14].

One of organic matter source is compost. Applying compost can contribute to agricultural sustainability. It improves soil physical and chemical properties as well as crop yield. Adequate use of compost with proper management has been shown to have many advantages. These advantages include adding an array of nutrients to soils [15], increasing SOM, improving water holding capacity and other physical properties of soil such as bulk density, penetration resistance and soil aggregation [10], [11], [16], [17], and beneficial effects on the growth of a variety of plants [18]- [21]. Effect of compost however depend on several parameters such as the compost ingredients, the compost quality, the soil type, and the compost dosage.

Some ingredients can be used to create compost. For example crops residue [22], green manure [12], and sewage sludge, [23]. Another alternative that could be used as a compost ingredient is chinna violet (*Asystasia gangetica* (L.) T. Anderson). This plant is a common weed in oil palm and rubber plantations. The usage of it as a compost ingredient is still rarely studied. In fact, it has great potential because it contains 37.87% C and 1.26% N, and 1.57% K. The objective of this study was to evaluate the short-term effects of china violet compost application on soil properties of Ultisol and peanut yield.

II. Materials And Method

A. Compost

Compost used in the experiments was produced Experimental Farm, University of Jambi, Indonesia. The raw materials used for compost were fresh china violet and fresh cow manure in 1:1 volumetric ratio. To speed up composting, the raw materials watered by extract of a mixture of papaya, banana, bean, cow intestines, palm sugar, and sugar cane at the beginning of composting. The mixture was co-composted in an aerated pile and turned every 3 days, for 3 weeks. During the composting process, the pile was watered regularly to maintain a moisture content. Compost was screened by a 10 mm screen at the end of composting process prior to application to soil. Analysis of compost was conducted for organic C, total N, total P_2O_5, total K_2O, and pH.

B. Field Experimental Design

The study was carried out at the Experimental Farm of University of Jambi, Indonesia, from July 2012 to December 2012. The soil is acid, low of organic C, total N, available K, and very low of available P.

The treatments were arranged in a randomized block design consisting of control (without compost), 5 Mg ha^{-1} compost, 10 Mg ha^{-1} compost, 15 Mg ha^{-1} compost, and 20 Mg ha^{-1} compost and replicated four times. Compost was applied to plots on a dry weight basis, incorporated into the soil to a depth of 20-30 cm two weeks prior to planting. The plot size was 2 by 3 m, planted peanut seed on 20 cm x 40 cm spacing. All treatment were suplemented by a chemical fertilizer that was 15 g plot^{-1} urea, 30 g plot^{-1} SP-36, and 30 g plot^{-1} KCl.

C. Sampling and Soil Analysis

Soil samples (0-20 cm) were collected on composite soil sample from each plot one day prior to harvesting. After air drying, the soil samples were ground to pass a 2-mm sieve and stored. Soil chemical properties were determined by organic C (Walkley and Black), total N (Kjeldahl), available P (P-Bray 1), exchangeble K (NH_4OA_C 1 N pH 7), pH (H_2O 1:2), and CEC (NH_4OA_C 1 N pH 7).

Undisturbed soil were taken at the 6 cm depth with metal cores of 4,0 cm diameter and 7,3 cm hight to determine bulk density, porosity, and soil water retention. Soil bulk density was determined using the core method. The soil samples were placed in an oven 105^0 C until achieving constant weight. The bulk density was calculated as the oven-dry mass of the soil sample divided by the core volume. Porosity was calculated from the soil bulk density using the equation, % porosity = 1 – (soil bulk density/particle density) x 100, where particle density was assumed to be 2.65 g cm^{-3}. Soil Soil water retention (as volumetric water content) was measured on the cores using pressure plate method (-33 and -1500 kPa) to determine available water content (AWC).

D. Sampling and Plant Analysis

The crop was harvested at full maturity, 98 days after planting. The pod and shoot were seperated. The pod was cleaned and dry in sun for 3-4 consecutive days. The yield of pod was adjusted at 12 % moisture level. The data on yield was recorded from 9 randomly selected plats from each plot.

E. Statistical Analysis

The results were analyzed by using analysis of variance at α 5%, considering soil and plat samples of each treatment as the independent variables. Mean values were separated by the Duncan Multiple Range Test at α 5%.

III. Results And Discussion

A. Compost

The chemical properties of the compost is presented in Tabel I. A low of C/N ratio of 18.57 indicated that decomposition process during composting produce a mature compost [24], [25], the quality of compost is moderate [26]. Reference [27] states composting caused a reduction of total organic C and weight by producing CO_2, whereas percentage of total N was increased.

TABLE 1
Compost Chemical Properties

Proverty	Unit	Value
organic C	%	25.63
Total N	%	1.38
C/N ratio	-	18.57
total P_2O_5	%	0.39
total K_2O	%	1.26
pH	-	6.90

B. The Effect of Compost on Soil Properties

The effect of compost on soil physical properties are summarized in Tabel II.

TABLE II.
The Effect Of Compost On Soil Physical Properties

Compost	Total Organic Carbon	Bulk Density	Total Porosity	Available Water Content
Mg ha^{-1}	%	g cm^{-3}	%	%
0	1.71	1.31	49.44	9.44
5	1.90	1.28	50.57	9.66
10	1.96	1.26	51.12	9.90
15	2.02	1.24	52.14	10.53
20	2.09	1.22	52.77	10.82

After amendements were applied, there were no significant differences in organic carbon among treatments. Generally, all treatments increase soil organic carbon content compared to the control. Increased application rates increased soil organic C content, and the highest organic C was found at 20 Mg ha^{-1} application. Numerous studies have shown that soil organic C increase following the introduction of organic amendements such as sludge [23], [28] paper mill residual and compost [11], [13], pulp and paper mill waste water [29], waste paper aplication [30]. On the other hand, the TOC content of the control plot decreased during the trial. These facts suggested that net carbon production by plants (e.g. roots, excudates, etc) less than carbon mineralization.

There were also no significant compost effect on soil bulk density, total porosity, and available water content after amendement was applied but in general, all trials tended to increase total porosity, available water content and to decrease bulk density compared to the control. Reference [31] found that amaendement effects on bulk density and other soil physical properties take more than one year to manifest themselves. Some studies have shown that appication of compost significantly decrease bulk density [32] - [34]. Assuming constant soil particle density, bulk density decreasre due to compost addition imply increase total porosity as well.

The effect of compost on soil chemical properties are summarized in Tabel III.

TABLE III.
THE EFFECT OF COMPOST ON SOIL CHEMICAL PROPERTIES

Compost (Mg ha-1)	pH	Total N	P	K	CEC
		%	ppm	cmolkg^{-1}	
0	5.05 a	0.16 a	15.98 a	0.23 a	6.16 a
5	5.19 a	0.17 ab	20.08 ab	0.40 ab	6.33 ab
10	5.36 ab	0.18 bc	22.43 ab	0.54 bc	6,58 bc
15	5.42 b	0.19 bc	24.75 b	0.58 c	6.78 c
20	5.63 b	0.20 c	35.65 c	0.72 c	7.01 c

Values followed in the same column with the same letters are not significantly different at the 0.05 level

Application of compost affected significantly soil pH, CEC, N, P, and K. Increases in rates of compost application caused enhancement of soil chemical properties. Enhancement of chemical properties occured due to the content of organic material in compost (TABEL I). Organic addition could cause organic carbon accumulation on the top soil [35]. Enhancement of soil organic carbon also increases soil humus or soil organic colloid which increase soil CEC [36], [37], [38]. Reference [39] showed, increases in soil chemical properties occures due to soil organic accumulation as a result of organic addition to soil and enhancement of microorganism which produces enzymes for degradation of organic materials. Mineralization of organic materials release inorganic N and P and other nutrients contained in organic materials [25]. Compost application increased soil P and K content compared to without compost application on planting maize, soybean, and wheat [40]. Reference [41] found that K in soil increased with organic decomposition. The increased of soil pH was probably due to the high pH value of the compost (TABEL I) [42].The highest soil pH, CEC, N, P, and K were founded with application of 20 Mg ha^{-1} compost.

Compost also affected the soil nutrient content. This was most evident for N and P, which both increased with the addition of compost. This effect depended on the level of compost used and was more evident at the highest dosage.
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C. *The Effect of Compost on Peanut Yield*

The effect of compost on peanut yield are summarized in Tabel IV. Compost application showed significant effect on pod dry weight of peanut. The increases of pod dry weight occured with increasing dosage of compost application. The highest pod dry weight was found with compost application of 20 Mg ha^{-1}.

TABLE IV.
THE EFFECT OF COMPOST ON PEANUT YIELD

Compost (Mg ha^{-1})	Pod dry weight (g plot^{-1})
0	169.51 a
5	212.68 ab
10	212.71 ab
15	237.40 b
20	245.58 b

Values followed in the same column with the same letters are not significantly different at the 0.05 level

Enhancement of pod dry weight was caused by improvement of soil quality. Improvement of soil quality resulting from compost application occurs owing to increasing quality and quantity of organic matter and subsequently improves soil productivity [7]. Organic materials underwent degradadation that released nutrients such as N, P, K, Ca, and Mg to the soil available for plant uptake [39]. Compost application was caused higher nutrient soil content and higher nutrient availability due to the presence of increased amounts of organic matter in the soil [43].

Another reason may caused by increasing the ability of micro nutrient [44], increasing soil pH by decreasing Al cation that was formed by Al-organic compond with organic application [45], improving soil biological properties so that efficiency of nutrient uptake and plant yield were increased [40], content of plant hormone that function as stimulant [46].

IV. CONCLUSIONS

Compost application did not improved soil physical properties but improved soil chemical properties and peanut yield. Improved soil chemical properties demonstated with increases in soil pH, CEC, N, P, and K. The highst compost application (20 Mg ha^{-1}) produced the best improvement of soil chemical properties and peanut yield.

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