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Application of Amelioran Compost of Empty Palm Plus Fruit Bunches to Soybean Plants in Ultisols through Multivariate Tests and Principal Component Analysis

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ABSTRACT

The decline in national soy output results from a decline in planted area. Optimizing ultisol land is one of the efforts undertaken to increase national soybean production. This study seeks to examine the effect of composting empty palm oil bunches on the growth and yield of soybeans using multivariate tests and principal component analysis during the compost's incubation period. The application of compost and empty palm fruit clusters was able to chelate Al-DD and increase the soil's available P and K. There is a positive Pearson correlation between pH, Ca, K, and Mg, as well as a positive Pearson correlation between all observed growth and development parameters of soybean plants. Pearson's correlation demonstrates the relationship between the characteristics of plant height, number of leaves, number of branches, number of pods, age of blossoming, age of harvest, and productivity. Positive correlations are observed for each parameter observed.

Keywords: *Multivariate Analysis, Principal Component Analysis, OPEFB Compost, Soybean, Ultisol*

1. INTRODUCTION

Soybean (*Glycine max* L.) is a globally significant sustenance plant that produces carbohydrates. Some individuals use soybeans to make tempeh, soybean oil, soy milk, and other processed dietary ingredients. Compared to other solid wastes, empty fruit bunches from oil palms are the largest refuse source. 23% of the waste generated from fresh fruit clusters is OPEFB (Yunindanova et al., 2013). OPEFB contains 1.08% total N, 1.32 ppm available P, 75.07 ppm available K, 731.26 ppm available Ca and 61.64 ppm available Mg (Purnamayanti et al, 2011) . OPEFB has the potential to be used as compost due to its high nutrient content and abundance.

Ultisols are one of the soil orders with the widest distribution, covering approximately 25 percent of Indonesia's land area, or 45 million hectares (Subagyo et al, 2004). Fertilization is one method to improve the fertility of ultisol soils for the growth and yield of soybean production. Due to the Ultisol soil's low pH and high Al-dd content, the elements P and K are rendered unavailable. (Tani et al., 2017) found that the addition of compost made from empty palm oil bunches can increase soil pH, overcome toxicity, and enhance soil characteristics.

There are physical, chemical, and biological restrictions on ultisol soil. Some of these characteristics are low to moderate organic matter, high Al-dd acidity, low N, P, and K K nutrient content, low CEC and KB values, and high erosion susceptibility. Even though ultisol soil has weak chemical properties, it can produce optimally if appropriately managed (Karnilawati et al., 2018).

Decomposition of OPEFB compost results in the formation of humic compounds. Humic compounds are acidic macromolecular organic acids that are most reactive in binding metal cations. On ultisol soil, the addition of Oil Palm Empty Fruit Bunch Compost Plus is anticipated to increase the yield of soybean plants (Haitami and Wahyudi, 2019). Pane et al. (2013) found that applying EFB compost significantly increased the total leaf area and stem diameter. The use of 1.2 kg plus 50 percent of the general dosage of compost significantly affects the expansion of rubber plant girth and yield (Saputra *et al*, 2019).

2. MATERIALS AND METHOD

This study was conducted at an altitude of 50 meters above sea level in an area with Ultisol-type soil. pH H2O 5.45 (acid soil category), N 0.31%, P 2.27 ppm, K 0.98 me/100 g, Ca 1.47 me/100 g, Mg 1.42 me/100 g, C-Organic 1.42 %, and Al-dd 1.20 me/100 g were determined by soil nutrient testing. Low levels of C-Organic, N-total, P, and K are present. Clay makes up 54.16 percent of the soil's texture. At the time of the investigation, monthly precipitation ranged from 35 to 250 millimeters. With precipitation between 7 and 14 days away. During the research, manual watering is performed despite the extremely low rainfall.

Making compost begins with counting OPEFB with a compost chopper machine. Empty palm fruit bunches plus 75% (52.5 kg) dry chicken manure 15% (15.5 kg) and to speed up the

decomposition process we add 10% lime to the total weight of the compost, which is 5 kg of agricultural lime, then given EM-4 0.5 % (500 ml per 50 kg of compost). Then covered with a tarpaulin and inverted for 2 months. This study used a randomized block design and then the data obtained from the research was carried out with a multivariate test and principal component analysis using SAS software version 9.0.

3. RESULT AND DISCUSSION

The relationship between the dose of compost with growth percentage, plant height, number of leaves, number of branches, number of pods and soybean productivity.

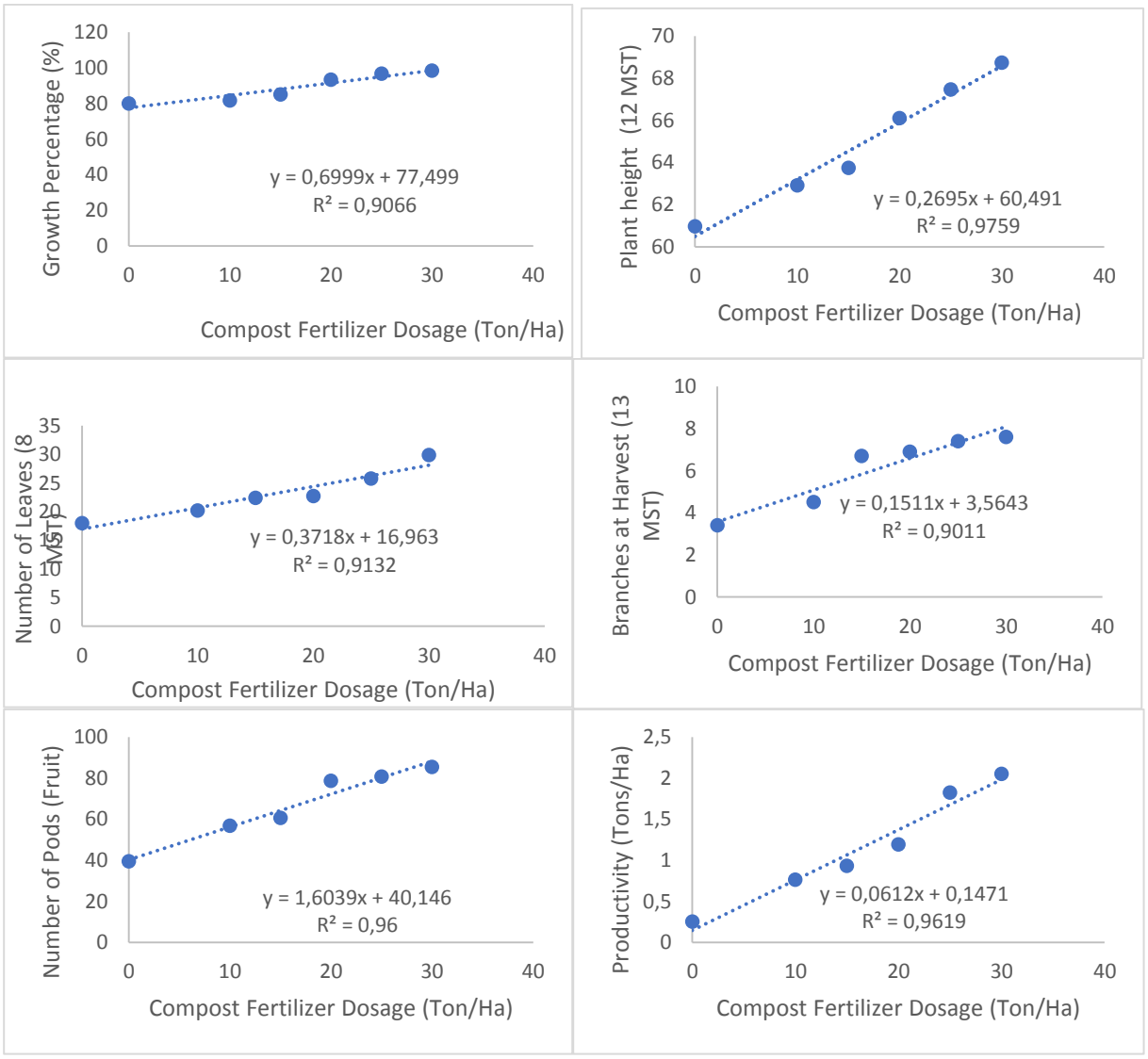

Figure. 1. Correlation between growing percentage, plant height, number of leaves, number of branches, number of pods and soybean productivity.

Plant height had a positive and significant correlation (p0.05) with the number of pods per plant (r=0.9066), plant height (r=0.9759), number of leaves

(r=0.9132), number of branches at the time of harvest (r=0.9011), number of pods (r=0.960), and productivity (r=0.9619) also had positive correlations. This indicates that in an independent state, the greater the height of the plant, the greater the number of leaves, branches, clusters, and soybean yield. The relative growth rate depicts a plant's capacity to produce additional dry matter over a given time period. This means all plant parts, not just the leaves, participate in photosynthesis and produce new plant parts (Junita *et al*. 2012).

Figure 1 depicts the relationship between growth percentage, plant height, number of leaves, branches, beans, and soybean yield. It can be seen that the growth percentage, plant height, number of leaves, number of branches, and number of soybean pods are consistent with plant growth and development and can increase soybean production on Ultisol soil when compost and empty palm fruit clusters are applied. This indicates a linear relationship between growth rate, plant height, number of leaves, branches, clusters, and soybean yield. This suggests that the plant grows vegetatively, develops, and can increase soybean production and the number of nutrients required by plants with a coefficient of determination (R^2) greater than 0.90. This is consistent with the belief (Marschner, 2012) that nutrients play an essential role in plant metabolism as activators of multiple enzymes. Potassium plays a role in synthesising proteins and carbohydrates and enhances the translocation of photosynthate to all plant tissues.

Pearson correlation on parameters of growth percentage, plant height, number of leaves, number of branches, number of pods and soybean productivity.

Table 1. Correlation analysis of plant height, number of leaves, number of branches, number of pods, age of flowering, age of harvest and productivity

	Test	Plant height	Number of Leaves	Number of Branches	Number of Pods	Flowering Age	Harvest Age	Productivity
Test	1.00000	0.9952** 0.0618	0.92714 0.2445	0.93710 0.2270	0.99999 0.0035	0.99049 0.0879	0.98160 0.1223	0.92522 0.2478
Plant height		1.00000	0.88643** 0.3064	0.89882 0.2888	0.99580 0.0584	0.9916 0.0260	0.95845 0.1842	0.95766 0.1859
Number of Leaves			1.00000	0.99962** 0.0175	0.92507 0.2480	0.86676 0.3324	0.98164 0.1222	0.71563 0.4923
Number of Branches				1.00000	0.93517** 0.2305	0.88015 0.3149	0.98651 0.1047	0.73458 0.4748
Number of Pods					1.00000	0.99123** 0.0844	0.98054 0.1258	0.92729 0.2443
Flowering Age						1.00000	0.94598** 0.2102	0.96863 0.1599
Harvest Age							1.00000	0.83574** 0.3701
Productivity								1.00000

Note: **=Significant correlation at level 0.01 (2-tailed); *=Significant correlation at the 0.05 level (2-tailed).

According to (Marschner, 2012), a plant's growth rate and yield can be hindered by a lack of sources and sinks. Fewer sources will delay sink charging as a result. Conversely, if there are many sources but few outflows, seed production will be low.

Pearson's correlation demonstrates the relationship between the characteristics of plant height, number of leaves, number of branches, number of pods, age of blossoming, age of harvest, and productivity. Table 2 displays positive correlations for all observed parameters..

Means and standard deviations values

Table. 2. Means and standard deviations from 3 observations

Variable	Mean	Standard Deviation
pH	5.5233333	0.18339393
Ca	2.1226667	0.29288280
K	0.6583333	0.04000417
Mg	1.6100000	0.07549834
Al-dd	0.6000000	0.20000000

Pearson correlation parameters pH, Ca, K, Mg and Al-dd

Table. 3. Pearson correlation between pH, Ca, K, Mg and Al-dd incubation period of empty palm fruit plus compost in ultisol soil

	pH	Ca	K	Mg	Al-dd
pH	1.00000	0.63414*	0.72628	0.65362	0.21811
Ca	0.63414	1.00000	0.99207**	0.99968	-0.61629
K	0.72628	0.99207	1.00000	0.99495**	-0.51245
Mg	0.65362	0.99968	0.99495	1.00000	-0.59604*
Al-dd	0.21811	-0.61629	-0.51245	-0.59604	1.00000

Pearson's correlation shows the correlation between the characters of pH, Ca, K, Mg and Al-dd. Positive correlations were shown for pH, Ca, K and Mg, while Al-dd had a negative correlation (Table 3). Soil pH is a soil chemical characteristic that is very important to know because it has a very broad effect on soil quality and land productivity (Bohn et al., 2005). Therefore, in land management, conditioning the soil pH to around pH 5.50 is something that must be done.

The relationship between pH and Al-dd is depicted in Table 3. The correlation coefficient (R) between pH and Al-dd at soil depth is -0.59604 and is substantially negative (*). This indicates that Al-dd decreases as soil pH rises. In accordance with the current theory, Al3+ ions predominate at pH levels below 4.70, while Al(OH)2+ ions predominate between 4.70 and 6.50. Al(OH)3 is the main form between 6.50 and 8.00 pH, while Al(OH)4 is the dominant ion above 8.00 pH (Abreu Jr et al., 2003; Bohn et al., 2005). The correlation between K and Al-dd is 0.99207 and -0.51245, indicating that soil K availability increases as Al-dd decreases.

Principal Component Analysis Values and Eigenvalues

Table. 4. Principal Component Analyses The Factor Procedure Initial Factor Methode: Principal Component. Eigenvalues of the Correlation Matrix: Total = 5 Average = 1

	Eigenvalue	Difference	Proportion	Cumulative
1	3.77497888	2.54995775	0.7550	0.7550
2	1.22502112	1.22502112	0.2450	1.0000
3	0.00000000	0.00000000	0.0000	1.0000
4	0.00000000	0.00000000	0.0000	1.0000
5	0.00000000		0.0000	1.0000

The proportional contribution of each factor from the first Eigenvalue pH, Ca, K, Mg, and Al-dd is 75% and 24%, respectively. In this case, only two phenomena have variable new factor contributions. While factor 5, despite being orthogonal, does not contribute only 0.00%. The MSA (Measure Sampling Adequacy) value is typically 70%. This suggests Al-dd is not a P adsorbent. It is believed that the Al-dd and orthophosphate ion precipitation reaction requires high concentrations to exceed the value of aluminium phosphate (Hartono *et al*. 2022).

Table. 5. Factor pattern

	Factor1	Factor2
pH	0.68008	0.73314
Ca	0.99814	-0.06094
K	0.99789	0.06497
Mg	0.99937	-0.03551
Al-dd	-0.56715	0.82361

Miniegen must have an adequate MSA value, namely a maximum of 2, because in factor 1 the value explained by each factor is 3.7749789 and factor 2 is 1.2250211. So the new orthogonal axis has several components where factor 1 is the most important. The components of pH, Ca, K and Mg, where the four components can be one, although the correlation cannot. This means that a high Al-dd value causes a low pH value and other macronutrients Ca and Mg (Hartono *et al*, 2022).

4. CONCLUSION

Compost made from empty palm oil bunches can enhance the chemical properties of ultisol soil by increasing soil pH, C-organic, and the ability to chelate Al to measurable levels. R^2 = 0.90 on all observed parameters, including yield, indicates that applying compost made from empty palm fruit clusters increases the growth of soybeans.

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