The utilization of ultisol soil for horticulture crops cultivation

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Abstract. Ultisol soil is a marginal soil commonly used for palm oil cultivation in Indonesia, its very potential for cultivation of horticulture crops. The utilization of ultisol soil can be done with adding compost with certain proportions. The research aimed to know best proportion of ultisol soil and compost, and proportion of water concentration, and its relationship with fresh and dry weight of horticulture crops. The research was divided 3 steps. The first, mixed ultisol soil and compost with certain proportion and flooding until steady. The second, watering with different concentration to soil mixture. The last, studied its relationship with fresh and dry weight of crops. The result show that physical properties and nutrient content of ultisol soil was increasing with adding compost. SC4 (70% soil and 30% compost) is the best composition to soil mixture. Watering with different concentration show that trend decreased significant level α = 0.05. Watering affect mass of pacoconut significantly at the significant level α = 0.05. Hence, ultisol soil was a potential marginal soil to utilizing as a media for cultivating horticulture crops.

1. Introduction
Ultisol soil (red soil) is a marginal soil, it’s determined low soil content and high pH value[1][2]. It explains that the soil chemist content is poor and so does the soil physics. Bulk density and particle density affect the stability of soil aggregate, and it can affect water movement and storage in soil[3]. The soil physics is the main properties, and the soil chemical and biological has been degradecaused by the use of chemical fertilizers[1]. It can be increased by using compost as a natural fertilizer, which it can increase organic matter, pH, enzyme activities, and soil respiration[4]. Compost contains many micro nutrient such as Mg, Co, Fe, N, P, and K, and it can affect available water[5].

Correlation of both soil particle and structure is important in water holding capacity[6]. Land use, processing, fertilizing, and compaction can change porosity, soil particle, and pores function, that affect chemical, physical and biological properties of soil[7]. Distribution of aggregate, organic matter content, mineral composition, and water content affect fluid transportation[8], the easiness of water flow through pores, it’s called permeability[9].

2. Materials and Method
This research was conducted at greenhouse laboratory, Agriculture Faculty, University of Sumatera Utara. The research was divided into three steps, they weremixed ultisol soil and compost with certain
proportions, watering the soil mixture with different concentration, and studied its relationship between fresh and dry weight of pakcoy.

2.1 Mixing ultisol soil and compost by certain proportions
The research started by entering mixture soil and compost to polybag with 10 kg capacity. Each polybag consists of ultisol soil and compost with certain proportions. The proportions were SC1 (100% soil + 0% compost) as control, SC2 (90% + 10%), SC3 (80% + 20%) and SC4 (70%+30%). Soil compaction was done by completely flooding the each polybag. Texture, bulk density, particle density, porosity, permeability, C-organic, organic matter, pH, nitrogen, phosphor, potassium are observed in the end of season with soil sample from each polybag.

![Fig 1. Mixture soil and compost inside polybag](image1)

2.2 Watering the soil mixture by different concentration
The best proportion used as a media for horticulture cultivation. The experiment was watering the sample by different concentration to look at the best concentration. The watering concentrations were 100% available water (AW) from field capacity as W1, 80% AW as W2 and then 60% AW as W3. As soon as watering was done, horticulture cultivation was done with pakcoy (Brassica rapa L.) as sample plants. Watering was done until the harvest-age of pakcoy. Soil sample was done in the end of season, hence, texture, bulk density, particle density, porosity, permeability was observed.

![Fig 2. Mixture soil and compost inside polybag with 70:30 composition](image2)

2.3 Relationship both watering and weight of crops
Pakcoy was harvested in 45 days after planting. Fresh and dry mass as a parameter observed in this research. Fresh and dry mass were measured to obtain the relationship of mass and watering.

3. Results and discussion

3.1 Mixing ultisol soil and compost
Soil texture is one of main parameter to study about soil, hence, the proportion of fraction affected soil physics characteristic. The comparison of sandy, clay and loam fraction should be known.
Table 1. Soil Physics and chemist analysis from mixture of soil and compost

| No. | Parameters                      | SC1       | SC2       | SC3       | SC4       |
|-----|---------------------------------|-----------|-----------|-----------|-----------|
| 1   | Texture                         | Sandy loam| Sandy loam| Sandy loam| Sandy loam|
| 2   | Bulks Density g.cm\(^{-3}\)     | 1.41      | 1.36      | 1.29      | 1.23      |
| 3   | Particle Density g.cm\(^{-3}\)  | 2.98      | 2.93      | 2.86      | 2.79      |
| 4   | Porosity %                       | 51.37     | 53.50     | 54.00     | 55.80     |
| 5   | Permeability cm.hour\(^{-1}\)   | 5.62      | 6.56      | 6.75      | 7.97      |
| 6   | C-organic %                      | 0.97      | 1.87      | 3.10      | 3.61      |
| 7   | Organic matter %                 | 1.67      | 3.22      | 5.34      | 6.22      |
| 8   | PH                              | 6.52      | 7.09      | 7.20      | 7.33      |
| 9   | Nitrogen %                       | 0.013     | 0.137     | 0.217     | 0.213     |
| 10  | Phosphor %                       | 20.90     | 29.13     | 35.48     | 42.25     |
| 11  | Potassium %                      | 0.491     | 0.669     | 0.702     | 0.761     |

Table 1 shows that sandy loam was the texture for each samples. The biggest proportion was sand (69.3%), followed by clay (16.3%) and loam (14.3%). Soil texture also affected bulk density and particle density. Adding compost caused the value of bulk density and particle density to decrease but not significantly, and increasing the value of porosity and permeability. If the value of bulk density decreasing, hence, the value of porosity will be increasing. There was negative correlation of bulk density and porosity.

Beside the soil physics, adding compost also affected the soil chemistry. C-organic, matter, pH, nitrogen, phosphor, potassium value was increasing which is caused by adding compost. The best experiment can be concluded that SC4 (70% soil and 30% compost) given the highest value than the other composition.

3.2. Watering with different concentration
Table 1 shows that the best compostion was 70% ultisol soil and 30% compost. Watering was done every day according the evapotranspiration value (ET) for each polybag (Table 2).

Sandy loam was soil texture of each samples with composition of sand (74.56%), clay (17.09%), and loam (8.35%). Table 2 show the value of bulk density and particle density increases and particle density. Watering affected bulk density and particle density but not significantly. Permeability was categorized to rather quick as categories[10].

Table 2. Soil physics analysis from watering experiment

| No. | Parameters  | Control  | W1      | W2      | W3      |
|-----|-------------|----------|---------|---------|---------|
| 1   | Texture     | Sandy loam| Sandy loam| Sandy loam| Sandy loam|
| 2   | Bulk Density g.cm\(^{-3}\) | 1.41     | 0.79\(^{A}\) | 0.84\(^{A}\) | 0.85\(^{A}\) |
| 3   | Particle Density g.cm\(^{-3}\) | 2.98     | 1.74     | 1.77     | 1.79     |
| 4   | Porosity %                           | 51.37     | 54.39\(^{A}\) | 52.34\(^{A}\) | 52.72\(^{A}\) |
| 5   | Permeability cm.hour\(^{-1}\)       | 5.62      | 7.76      | 7.07      | 6.15      |

3.3. The relationship both watering and weight crops
To obtain the relationship of watering and weight of crops, pakcroy used as experiment plant. Steam and leaves, and root weight also were scaled to obtain the effect of watering with different concentration (Table 3).
Table 3. Fresh weight and dry weight of pakcoy

| No. | Treatment | Fresh weight (gram) | Dry Weight (gram) |
|-----|-----------|---------------------|------------------|
|     |           | Stems and leaves    | Root             | Stems and leaves | Root |
| 1   | W1        | 57.50<sup>ab</sup>  | 1.64<sup>a</sup>  | 4.04<sup>a</sup>  | 0.21<sup>a</sup> |
| 2   | W2        | 58.75<sup>ab</sup>  | 1.69<sup>a</sup>  | 3.61<sup>a</sup>  | 0.18<sup>a</sup> |
| 3   | W3        | 70.00<sup>ab</sup>  | 1.99<sup>a</sup>  | 5.09<sup>a</sup>  | 0.22<sup>a</sup> |

Table 3 shows that there is negative correlation of watering concentration and fresh weight of pakcoy. The lower watering concentration, hence, the higher fresh weight of pakcoy. However, W2 was different and having positive trend on fresh weight.

Fresh weight was 57.50-70.00 grams for stems and leaves, and 1.64-1.99 grams for root. It’s lower than standard mass of fresh. Dry weight was 3.61-5.09 grams for stems and leaves, and 0.18-0.22 grams for root. Overall, there was no significant difference all of them.

The data above can explain that adding compost to ultisol soil can increase soil physical and chemical. The proportion of soil fraction, affects bulk density and also porosity. The value of bulk density affected porosity as high. The focused concern of data was the different value both SC4 flooding and SC4 watering in soil physical properties. Flooding has not doneydaly like watering. Aggregate stability can be movement parallel with water push from watering [3]. It can affect the value of bulk density to decrease from the reference.

There are significant difference between flooding and daily watering in bulk density and particle density. Flooding caused water to fill all of pores, and caused soil compaction which the bulk density and particle density value to increase. It’s different with watering while water given according to ET value. Water is forced to fill in all of pores, and it’s also given was according to field capacity of soil. Table 2 shows that there was no significant difference between W1, W2, and W3. It means the water can be given to match capacity of available water.

Mass of pakcoy does not satisfy the standard mass of pakcoy which government had issued, KEMENTAN No. 253/kpt/TP.240/5/2000 which stated that standard mass of pakcoy is 250-300 g. Compost additionally can increase water holding capacity while increasing organic matter. Whereas water given has no significantly affected the mass of pakcoy, but it needs a big energy to water suction in ultisol soil. Mass of pakcoy not fulfill the standard, furthermore, ultisol soil is a potential soil to be utilized as a media for cultivating the horticulture crops.

4. Conclusions
The research can be concluded that the best proportion is SC 4 that consist of 70% ultisol soil and 30% compost which can be use as a media of horticulture cultivation. Flooding and watering given affects bulk density and porosity, and watering affects bulk density and porosity but not significantly. Watering affects mass of pakchoy not significant also. Ultisol soil is a potential soil to utilizing as a media for cultivating the horticulture crops.

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