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ASSESSING THE PHYSICAL PROPERTIES OF SOIL ON FREQUENTLY PLANTED LAND WITH SHALLOTS AT GUNTARANO VILLAGE, DONGGALA REGENCY, CENTRAL SULAWESI

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ABSTRACT

The red onion of the Palu Valley variety is a type of shallot that grows well in the Palu valley and its surroundings. It has a distinctive taste when fried, so it is one of the souvenirs from the city of Palu. This study aimed at examining the soil's physical properties on land often planted with shallots. This research was conducted in Guntarano Village, Donggala Regency. Soil samples were analysed at the Laboratory of Soil Science, Faculty of Agriculture, University of Tadulako. The research was carried out from June to November 2022. The method used was a survey method and the research location was determined deliberately (purposive sampling). The soil samples were taken on shallot farming land at flat and back of the slope. Depending on the area of the land, there were five composite samples where each composite sampling representing from 5-10 points of observation. The results of analystzing the physical properties of the soil showed that the shallot fields had a crumb to lumpy soil structure; medium to heavy bulk density; soil organic matter varied from medium to high; and water conten at field capacity range from 16.12% to 22.85%. The soil in the shallot farming area has begun to show poor soil quality due to high soil porosity (66,09 %) and high soil permeability (13,10 cm/hour).

Keywords: Shallot Field, Soil Physical Properties.

INTRODUCTION

Shallots (Allium ascalonicum L.) is a horticultural crop that has high economic value because many people consume shallots as a food seasoning so the demand for shallots is very high, especially in Central Sulawesi. The shallot plant is a short-lived annual plant, with shallow fibrous roots, in the form of clumps and the leaves changes shape to become a bulb. Shallots are classified as important spice vegetables because of their benefits as ingredients for everyday cooking (Supadma *et al*. 2020). Land use is very important along with the increasing needs which are directly proportional to the increase in population and technological advances. While the ability of land in an area has different properties and characteristics so the ability of the soil to increase crop productivity also varies. Identification of soil properties is very important to note in determining soil capabilities (Wilson et al. 2015). The importance of identifying soil properties is to determine soil conditions in order to improve the physical, chemical and biological properties of the soil.

Tewu et al. (2016) explains that soil physical, chemical and biological properties are crucial in supporting plant growth and development. Soil physical properties include texture, structure and soil permeability. Soil chemical properties include soil pH, C-Organic, CEC and nutrient content. Nutrient content, consisting of N, P, and K content. Soil biological properties include micro-organisms that decompose organic matter in the soil. Soil chemical properties are one indicator to determine the level of land capability. The chemical properties of the soil show ionic activity which cannot be seen directly but can be tested using chemicals. Soil chemical properties can also be used as a recommendation in fertilizing for plant nutrients (Ansar *et al*., 2019).

The shallot production development area in Central Sulawesi is Donggala Regency. Onion productivity in Donggala Regency has generally fluctuated over the last 5 years. This can be seen from the production of shallots from 2018 to 2021 which decreased by around 22.58%, while in 2022 it experienced a very sharp increase of 51.60%. This happened because in 2022 the tertiary irrigation channels were repaired.

Donggala Regency consists of several districts. Districts that produce shallots are Tanantovea District and Labuan District. Tanantovea Sub-District was declared a red onion production centre area in Donggala Regency because it was able to produce a productivity of 6.52 tons/ha, while Labuan Sub-District produced a productivity of 5.48 tons/h. Guntarano Village has high potential in the agricultural sector as the foundation of the community's economic life such as rice fields, chili plantations, shallots and so on. However, the economic of the people in Guntarano Village has not been maximized. Based on this situation, the authors are interested in conducting research on the analysis of soil physical properties on shallot land use.

The purpose of this study was to determine the condition of the physical properties of the soil in the shallot farming area in Guntarano Village.

RESEARCH METHODS

Field research was carried out in Guntarano Village, Tanantovea District, Donggala Regency. Soil analysis was carried out at the Laboratory of Soil Science Unit, Faculty of Agriculture, Tadulako University. The research was conducted from June to November 2022. The tools used in this study were GPS (Global Positioning System), sample rings, cutter, hoes, crowbars, plastic bags, markers, blocks, hammers, tape measure, rubber bands and stationery. The materials used were disturbed and undisturbed soil samples, as well as some water and chemicals to be used in laboratory analysis. The method used in this research is a descriptive method with a direct survey approach in the field. Determining the location for taking and observing soil samples was carried out by purposive sampling (intentionally). Sampling was adjusted to the conditions of the land in the field.

Research Implementation

Preparation phase.

Initial preparations were made, namely preparing research proposals, preparing tools and materials used in the field, and conducting surveys to obtain information related to research activities. The use of land used as a place for taking soil samples is shallot plantation land.

Field Activities.

Soil sampling was carried out according to the sample point map of

Guntarano Village, where the determination of the point was based on the condition of the shallot cropland. Soil sampling was carried out by drilling and using a sample ring (undisturbed soil sampling), after the soil sample was obtained then for disturbed soil it was colected in a plastic bag and labelled.

Data analysis.

The parameters used for soil analysis include soil structure, soil bulk density, soil aggregates, soil organic matter content, soil porosity, moisture content, water content at field capacity, and soil permeability.

The method used in determining soil structure is a qualitative method using disturbed soil samples (in the form of lumps) with the help of a field knife with a diameter of ≤ 10 cm. Break the lump by pressing the finger, the fraction of the lump is an aggregate or a combination of aggregates. Then observe the shape of the soil structure and match it with the criteria for the shape of the structure. The method used in soil texture is the pipette method. The measurement of the unit weight value of soil was carried out by taking intact soil samples in the field using a sample ring and then weighing the weight of the dry soil after being oven-dried for 24 hours at 105 degrees Celsius. The soil porosity test is carried out after obtaining the volume weight value of the soil (bulk density) and the value of the soil particle weight (particle density).

The method used in determining soil organic matter is the Walkley and Black method. The steps carried out in this method are the intermediate stages, namely the organic matter content is determined by the C-organic titration results and then multiplied by a constant. Determination of soil field capacity water content using gravimetric method. Field capacity water content was measured by means of soil samples from the measurement of saturated water content, drained again for 24 hours, then weighed and then oven-dried at 105°C for 24 hours. Calculation of permeability using a permeameter with the Constant Head Permeameter method, namely the height method of water pressure.

RESULTS AND DISCUSSION

The results of the analysis of soil structure on the land planted with shallots are presented in Table 1.

Table 1. Soil structure at the research location

Sample No	Type of Soil Structure	Aggregate properties
1	Clump	Clump, cube shape, aggregates hold tightly to each other, smaller aggregates occur when broken.
2	Crumbs	Round, small, shaft, not bound between aggregate
3	Crumbs	Round, small, porous, not bound between aggregates
4	Crumbs	Round, small, porous, not bound between aggregates
5	Clump	Clumps, cube shape, aggregates hold tightly to each other, smaller aggregates occur when broken.

*) Arsyad (2001).

Table 2. Soil Texture Analysis Results.

No	Particle (%)			Texture*
	Sand	Silt	Clay	
1	46,6	41,0	12,4	Loam
2	79,7	11,4	8,9	Sandy Loam
3	78,7	20,5	0,9	Sandy Loam
4	59,1	22,7	18,3	Sandy Loam
5	45,8	41,3	12,9	Loam

* Harjowigeno (2007)

Results of observations of soil structure in the field, sample points 2, 3, and 4 have a crumbly soil structure type, while points 1 and 5 have a lumpy soil structure type. Good soil structure in the field is usually rounded so that they cannot touch each other tightly and are not of a clay texture. As a result of good soil structure, the presence of many soil pores is formed, besides that the soil is not easily damaged so the soil pores are closed when it rains (Arsyad, 2001). The benefits obtained by knowing the shape, size, and development of soil structure, for example for large soils such as cubes and columns, will result in: slower infiltration, slower permeability, slower percolation, higher water content, and heavier tillage or difficult (Sallata, 2011).

The results of the analysis of soil texture on the land planted with shallots are presented in Table 2.

Based on the results of soil texture analysis samples points 1, and 5 have a clay texture class, while points 2, 3, and 4 have a sandy loam texture class. Sand-dominant soil is good for tuber development and also water passage so the tubers don't rotten. Conversely, clay-dominant soil will inhibit tuber growth. In addition to tuber growth, sandy soil is very useful for facilitating the harvesting of shallots. This is supported by Rismunandar (1986), which states that shallots can grow in almost all types of soil and prefer sandy loam soil types. Shallots need a lot of water but wet conditions cause rot disease. Soil that is sufficiently moist and the water is not stagnant is preferred by shallot plants (Galagi *et al.*, 2017). According to Daria *et al*. (2004), dust is the soil fraction that is most easily eroded, because apart from having a relatively fine size, this fraction also does not have the ability to form bonds (without the help of adhesives/binders) because it has no charge. In contrast to dust texture, although clay is fine in size because it has a charge, this fraction can form bonds.

The results of the analysis of soil bulk density on the land planted with shallots are presented in Table 3.

Table 3. Results of Soil Bulk Density Analysis.

No	Soil Bulk Density ($g.cm^{-3}$)	Criteria*)
1	1,59	Heavy
2	1,34	Moderate
3	1,47	Heavy
4	1,58	Heavy
5	1,60	Heavy

* Puslitanak (2005).

Based on the data in Table 3, the results of analysing soil bulk density at sample points 1, 3, 4, and 5 have criteria heavy while at sample point 2 the criteria are moderate. This is influenced by the content of each soil texture dominated by sand which causes a small number of soil pores to form, organic matter, and the presence of soil compaction so that the volume weight value of the soil will increase. Soil bulk density greatly influences the productivity of plant roots because it relates to the organic matter in the soil. Where the more organic matter in the soil, the higher the bulk density of the soil and the greater the influence on plant growth. In addition, we know that the bulk density of the soil has a reciprocal relationship with the porosity of the soil (Islami and Utomo, 1995).

In line with the opinion expressed by Endriani *et al.* (2009), that the higher the soil organic matter, the lower the unit weight (body weight) so that the resistance to soil penetration decreases. The decrease in the volume weight of the soil is thought to be due to the decomposition of various sources of organic matter into soil organic matter so that it is able to reduce the volume weight of the soil, the dense structure becomes crumbs so that the soil is easier to cultivate. Bulk density is an indication of soil density which shows the difference between the dry weight of the soil and the volume of the soil including the pore volume of the soil, which is expressed in $gr.cm^{-3}$. Bulk Density (BD), namely the weight of solids (at constant dry) divided by the total volume (solids + pores), the ideal soil BD ranges from 1.3-1.35 $g.cm^{-3}$, BD in soil ranges from > 1.65 $g.cm^{-3}$ for sandy soils; 1.0-1.6 $g.cm^{-3}$ in loamy soils containing medium-high soil organic matter. Bulk Density may be less than 1 $g.cm^{-3}$ in soils with high organic matter content (Tarigan *et al.* 2015).

Results of the analysis of soil organic matter content on the land planted with shallots are presented in Table 4.

Table 4. Results of Soil Organic Matter

No	Organic Matter (%)	Criteria*)
1	2,33	Moderate
2	4,38	High
3	4,14	Moderate
4	3,77	Moderate
5	2,15	Moderate

* Puslitanak (2005).

Based on the results of analysing organic matter in Table 4, sample points 1, 3, 4, and 5 have moderate criteria, while sample point 2 has high criteria. The level of organic matter content is influenced by the amount of vegetation that contributes a lot of litter through decomposition. The varying organic C content in these lands is due to differences in the type and amount of vegetation that grows on the land. Munawar (2013) further explained that soil organic matter is all the carbon in the soil that comes from the remains of plants or animals that have died. Most sources of soil organic matter are plant tissues or plants. Different sources and amounts of organic matter will have different effects on the organic matter contributed to the soil.

Organic matter in the soil will be decomposed by soil organisms. The decomposition of organic matter in the soil releases the nutrients and will be binded into simple compounds that are close to the needs of plants. The function of organic matter is as a source of food and energy for micro-organisms, helping plant nutrition through self-renovation and through its humus exchange capacity, providing substances needed for the formation and stabilization of soil aggregates, improving water binding capacity. and passing water as well as assisting in controlling surface runoff and erosion (Sudaryono, 2001).

Results of the analysis of soil porosity on the land planted with shallots are presented in Table 5.

Table 5. Results of Soil Porosity Analysis.

No	Porosity (%)	Criteria*)
1	56,91	Good
2	66,09	High
3	62,72	High
4	60,10	High
5	54,67	Good

* Kusuma *et al*. (2013).

Based on the results of the soil porosity analysis in Table 5, sample points 2, 3, and 4 have high criteria, while sample points 1 and 5 have good criteria. Total porosity is the easiest initial indicator to determine good or bad soil structure. Soil porosity will be high if the organic matter content in the soil is also high. Soils with crumb and granular structures have higher porosity than soils with dense structures. Hanafiah (1995), states that porosity reflects the degree of ease of soil for water flow to pass through (permeability) or the velocity of water flow to pass through the soil mass (percolation). Soil porosity is strongly influenced by organic matter content, soil structure, and soil texture (Njurumana, *et al*. 2008). According to Evarnaz, *et al*. (2014), high porosity and organic matter can reduce the density of soil contents because organic matter is much lighter than minerals and organic matter also increases soil porosity. According to Nugroho (2009), soils with a crumb structure (granular) have higher porosity than soils with a solid structure (massive).

According to Hanafiah (1995), soil with a sandy loam texture is better than clay-textured soil, because it is dominated by sand, there are many macro pores called more porous, the larger the porous soil, the easier it is for water and air to circulate (drainage and aeration). This is supported by the statement of Setyowati (2007), that the higher the percentage of sand in the soil, the more pore space between soil particles, and the more it can facilitate the movement of air and water. But if water is not managed properly, it can result in excessive leaching of nutrients which can affect the decline in soil fertility.

The results of the analysis of soil water content at field capacity on the land planted with shallots are presented in Table 6.

Based on the results of the field capacity water content analysis in Table 6, sample point 2 has the lowest field capacity moisture content, while sample point 5 has the highest value. Several factors affect the water holding capacity at field capacity, including texture and organic matter. Condition of high or low water content is due to the organic matter content. The higher the organic matter, the higher the field capacity. According to Sukmana (1984), organic matter has a high ability to absorb and hold water. Water content at the land with slope of 8-15% is higher than with slope of 0-8%. This is because the slope of 8-15% is gentler than the slope of 0-8%. The sloping slopes can accommodate the amount of rainfall that falls on the surface of the soil so that the rate of erosion that occurs is smaller. According to Refliaty and Marpaung (2010), the steeper the slope, the greater the erosion because the rainfall cannot be completely absorbed and most of it becomes runoff. Moreover the infiltration rate will be immobile, consequently the availability of water in the soil is low (Mujiyo *et al*., 2021).

Table 6. Field Capacity Water Analysis

No	Moisture Field Capacity %
1	18,93
2	16,12
3	17,08
4	17,76
5	20,85

The results of the analysis of soil permeability on the land planted with shallots are presented in Table 7.

Table 7. Soil Permeability Analysis Results.

No	Permeability (cm.hour$^{-1)}$)	Criteria*
1	6,85	Moderate
2	13,10	Slightly Fast
3	10,26	Moderate
4	7,32	Moderate
5	6,34	Moderate

* Arsyad (2001)

In the soil permeability analysis at sample points 1, 3, 4, and 5, the criteria are moderate, while at sample point 2, the criteria are rather fast on shallot land use. In general, the permeability value increases with more porousness. Rahim (2003)stated that structure and texture as well as organic elements take part in increasing the rate of permeability. Soils with high permeability increase the infiltration rate and decrease the runoff rate. The permeability coefficient mainly depends on the particle size and particle shape. The smaller the particle size, the smaller the pore size and the lower the permeability coefficient. It means that a layer of coarse-grained soil contains lower fines and in soils the permeability coefficient is a function of the void ratio.

Soil permeability is one of the important soil property parameters to predict lateral seepage in the event of precipitation (rain). Rohmat and Soekarno (2006), argue that permeability expresses the ability of porous media, in this case, soil to pass liquids (rainwater) both laterally and vertically. Soil permeability level (cm/hour) is a function of various soil physical properties. This is in accordance with the opinion of Rohmat and Soekarno (2006), stating that soil physical properties that affect soil permeability are soil water content, soil volume weight, total porosity, fast and slow drainage pores, coarse and fine sand content, silt and clay content.

CONCLUSIONS AND RECOMMENDATIONS

Conclusion.

Based on the results of the research above, it can be concluded that:

1. Most area of shallot plantation still shows a good physical soil structure category with crumb to lumpy; soil bulk density with moderate to heavy criteria; soil organic matter content varying from 2.15% to 4.38% with medium to high criteria and high levels of organic matter. The water at field capacity were between 16.12% to 20.85%.
2. Some part of shallot plantation area has begun to show poor soil quality due to high soil prosity (66,09 %) and high soil permeability (13,10 cm/hour).

Recommendation.

Based on the research results, it is necessary to carry out routine tillage and regular organic fertilization in order to improve the condition of the physical properties of the soil and increase soil fertility.

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