Monitoring Soil Quality in Cassava Cultivation Through Organic Matter Management

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ABSTRACT

This study aims to study the effect of applying organic matter to improving soil quality and to study the effect of improving soil quality on cassava production. Cassava plants (Manihot esculenta Crantz) are future crops, in which case the commodities cultivated in agriculture in today's society this is very monotonous, without any changes, for example by planting rice, corn or other grain crops, which is continuously carried out in farming communities. The various characteristics of cassava plants strengthen the notion that cassava is a plant that can accelerate land degradation. This assumption seems to be justified by the fact that most cassava plantations are marginal lands. Cassava centers are generally located in areas of marginal land (dry land) which have suboptimal physical characteristics including: sensitivity to erosion and low fertility. Facing these conditions, increasing land productivity is the main requirement for achieving the target of increasing the optimization of sustainable cassava production. Achieving sustainable land productivity can be done through a land maintenance system approach. The land maintenance system is a continuous and comprehensive improvement and monitoring concept compared to land conservation. One of them is by managing organic matter and monitoring soil quality. This study used 30 plots with 10 treatments and 3 replications where each plot was 8 m x 4 m in size.

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1. INTRODUCTION

In Indonesia, cassava plants have not received much attention and are even often called plants that quickly damage the soil. This is because cassava plants have a low leaf canopy area so they are unable to protect the soil from rainwater blows. Cassava plants produce low organic matter, and cassava plants are also considered to transport more nutrients than other plants.

As a result, efforts to develop these plants experienced difficulties so that national production which was expected to meet domestic needs and export demand was never achieved. it is very monotonous, without any change. For example by planting rice, corn or other grain crops, which is continuously carried out by farming communities in general, so that there is a saturation of this. For this reason, cassava plants are present as an alternative food commodity that is suitable for overcoming the above problems, which are expected to be able to provide optimal results and benefits for the farming community in Indonesia as a whole.

Besides that, cassava plants can also be used for various purposes, ranging from animal feed ingredients, industrial raw materials to raw materials for bioenergy (biofuel). From a production perspective, if the increase in grain crop production has experienced a “leveling off”, the increase in cassava production is still very potential. cassava as a plant that can accelerate land degradation.

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The application of the traditional cassava cultivation system, followed by land management and the provision of low farming inputs, will accelerate the process of decreasing land quality, especially on marginal lands that have naturally low land quality. By paying attention to these problems, land improvement needs to use a new approach.

The approach developed must be able to answer the needs of farmers, namely increasing land productivity. Talking about the problem of increasing land productivity and sustainable agriculture is an effort to improve soil quality (Utomo, 2001). Soil quality in question is the capacity of the soil to carry out its functions within natural or artificial ecosystem boundaries to maintain plant productivity, maintain and improve water and air quality, and support human health (Karlen et al., 1996.

2. METHOD

2.1 Types of research

The research method used in this research is survey method (descriptive) with collection based on an assumption about geographical phenomena which can be directly identified from the interpretation of images with a qualitative descriptive approach.

2.2 Research Variables

The research variable was the type of soil taken when the plants were 6 months old using a 10 cm diameter PVC pipe at a depth of 0 - 20 cm. The soil was analyzed for BI, BJ, porosity, aggregate stability and permeability.

2.3 Research design

This study used a randomized block design (RBD) with 10 treatments and 3 repetitions. The dose of Urea 300 kg/ha was adjusted to the optimum needs of cassava plants in one growing season, namely between 200-375 kg/ha, SP36 between 60-164 kg (maximum dose) and KCL between 100-312 kg (maximum dose) (Junedi and Howeier, in Sugito, 1991). For organic fertilizer, 10 tons/ha is adjusted according to the amount of dissolved organic matter added to the soil, namely 8-9 tons/ha (Hairiah et al., 2000) which is rounded up to 10 tons/ha. Provision of organic fertilizer 5 tons / ha because it is done in combination with urea.

2.4 Sampling location

This study used 30 plots with 10 treatments and 3 replications where each plot was 8 mx 4 m in size.

2.5 Time and Place of Research.

The research was conducted at the Experimental Garden of the Faculty of Agriculture, University of Brawijaya in Jatikerto Village, Kromengan District, Malang Regency for 9 months (October 2008 - July 2009).

2.6 Tools and Materials

Soil sampling was carried out using tools such as hoes, earth knives, plastic bags, paper, hammers, wooden blocks and PVC pipes with a diameter of 10 cm. To observe the physical and chemical properties of the soil, use the equipment available in the soil physics and chemistry laboratory as well as a scale to weigh the fresh cassava at harvest.

The materials used are: Soil samples taken using a PVC pipe with a diameter of 10 cm at a depth of 0 - 20 cm; Cassava seeds (faroka stem cuttings); Inorganic fertilizers (Urea, SP36, KCL); Organic fertilizer consisting of: Manure; Blotong; in the form of bagasse residue; Compost.

2.7 Research procedure

Intact soil samples were taken using a 10 cm diameter PVC pipe and disturbed soil samples at a depth of 0-20 cm. then a soil analysis was carried out in the laboratory which consisted of the physical and chemical properties of the soil by starting to plant corn and cassava seeds and carrying out maintenance and followed by fertilization and data analysis.

2.8 Data analysis.

Observations were analyzed using analysis of variance (Anova), from these results if there is a significant difference it is continued with Duncan's test at the 5% level. To find out the closeness and form of the relationship between parameters, a correlation test was carried out using SPSS 12 for windows and Microsoft excel.

3. RESULTS AND DISCUSSION

3.1 Research result

To determine the effect of applying organic matter to improving soil quality, several parameters were used, namely the physical and chemical properties of the soil. The physical parameters included: bulk density, porosity, aggregate stability, and permeability. While soil chemical parameters include N-total soil, CEC, soil acidity (pH), and soil organic matter content.

3.1.1 The Effect of Giving Organic Materials on Soil Physical Properties.

The results of the analysis of the physical properties of the soil indicate that there is an improvement in soil properties in the management of organic matter. Statistically this shows a significant difference (Sig. <5%). the physical properties of the soil are divided into several parts, including soil bulk density, bulk density (g/cm3) Porosity (%) Stability (DMR) KHJ (cm/hour).

Table 1. Average 9th Hour Medium Turbidity (S.aureus Indicator Bacteria) in Fermented Milk Beverage Products Circulating in Malang City

No	Treatment	Filling weight (g/cm^3)	Porosity (%)	Stability (DMR)	KHJ (cm/hour)
1	P1	1.35b	44,55a	1.25a	5,58a
2	P2	1.26ab	45,51ab	1.57ab	5,78a
3	P3	1.22ab	49.59abc	1.49ab	8,26ab
4	P4	1.18ab	49.65abc	1.97abc	12.30bc
5	P5	1.17ab	52.78abc	1.84ab	12.02bc
6	P6	1.14ab	52.01abc	2.51bc	16,84c
7	Q7	1.09ab	55.80c	2.19abc	16,22c
8	Q8	1.08ab	53,86bc	2.11abc	7.53ab
9	Q9	1.07a	56,88c	2.90c	9.98ab
10	P10	1.10ab	51.84abc	1.92abc	8,16ab

Note:
- Numbers accompanied by the same letter are not significantly different in Duncan's test at 5% level
P1 : Control P6 : Compost 10 ton/ha
P2 : Urea Fertilizer P7 : Urea Fertilizer + P. Cages 5 tons/ha
P3 : Urea Fertilizer + SP36 P8 : Urea Fertilizer + Compost 5 ton/ha
P4 : Urea Fertilizer + SP36 + Kcl P9 : Urea Fertilizer + SP36 + Compost 5 tons/ha
P5 : Manure 10 tons/ha P10 : Urea Fertilizer + Blotong 5 tons/ha

The treatment of organic fertilizers, both organic fertilizers alone (P5 and P6) and combinations (P7, P8, P9, and P10) had a significant effect on soil bulk density when compared to inorganic fertilizer treatments (P2, P3, P4). The average value of soil unit weight in the organic fertilizer treatment was lower when compared to the inorganic fertilizer treatment. The average reduction in soil density in the application of organic fertilizers was 14.79%, greater than the treatment of inorganic fertilizers which decreased only by 9.61% and in the porosity of the treatment of organic fertilizers, both organic fertilizers alone (P5 and P6) and a combination (P7, P8, P9, and P10) had a significant effect on soil porosity when compared to inorganic fertilizer treatments (P2, P3, P4).

The average value of soil porosity in the organic fertilizer treatment was higher when compared to the inorganic fertilizer treatment. The average increase in porosity in the fertilization treatment was 16.72%. The lowest soil porosity value was shown in the Control treatment without fertilization, which was 44.55%. Stability of soil aggregates has a positive correlation (r = 0.701**) with soil porosity. This shows that the increase in the stability value of soil aggregates is due to the high pore space in the soil so that the higher the porosity of the soil, the higher the stability of the soil aggregate itself and the application of organic fertilizers has a significant effect on soil permeability (Sig. <5%). The results of the Duncan test showed that the control had a significantly different Permeability value and was the lowest compared to other fertilization treatments. The permeability value for the control is 5.58 cm/hour.

3.1.2 The Effect of Giving Organic Materials on the Chemical Properties of Soil

The results of the analysis of soil chemical properties show that there is an improvement in soil properties in the management of organic matter. However, statistically this did not show a significant difference (Sig.> 5%). Following are some important parts of soil chemical properties on the influence of organic matter acquisition.

Table 2. Effect of Organic Matter Application on Soil Chemical Properties.

No	Treatment	N-total (%)	BO (%)	CEC (cmol/kg)	pH
1	P1	0.63a	0.89a	9,84a	5,58a
2	P2	0.75ab0	1.24ab	10.83ab	5,67a
3	P3	0.84abc	1.24ab	11.83ab	5.98a
4	P4	0.96bc	1.16ab	11.85ab	6,08a
5	P5	0.81abc	1.82ab	11.32ab	6,11a
6	P6	0.91bc	1.62ab	11.33ab	6,36a
7	Q7	0.84abc	1.29ab	11.32ab	6,25a
8	Q8	0.86abc	1.40ab	10.84ab	6,27a
9	Q9	1.02c	1.86b	14,81b	6,18a
10	P10	0.93bc	1.79ab	12.81ab	6,40a

Note:
- Numbers accompanied by the same letter are not significantly different in Duncan's test at 5% level
P1 : Control P6 : Compost 10 ton/ha
P2 : Urea Fertilizer P7 : Urea Fertilizer + P. Cages 5 tons/ha
P3 : Urea Fertilizer + SP36 P8 : Urea Fertilizer + Compost 5 ton/ha
P4 : Urea Fertilizer + SP36 + Kcl P9 : Urea Fertilizer + SP36 + Compost 5 tons/ha
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The addition of organic matter to the soil can increase the stability of the aggregate and soil porosity and reduce the bulk density of the soil. Decomposed soil organic matter will undergo decomposition of its constituent compounds into several elements, including C < H < and O. The distribution of soil organic matter content varies according to the amount of input and the amount of decomposed organic matter The treatment of organic fertilizer application has no significantly different effect on CEC soil (Sig.>5%). The results of the Duncan test showed that there were significant differences between the fertilization treatments for soil CEC. The highest CEC was produced in the P9 treatment (Urea Fertilizer + SP36 + 5 tons/ha compost) of 14.81 cmol/kg and the lowest yield was obtained from the Control treatment, which was 9.84 cmol/kg.

The application of combination fertilizers showed a higher value compared to organic and inorganic fertilizers. The highest pH was obtained in the P9 treatment (Urea Fertilizer + Sp36 + Compost 5 tons/ha) which was 6.40. Whereas in the inorganic fertilizer treatment it only ranged from 5.98 - 6.11, but for the organic fertilizer treatment alone it produced a pH value that was not different from the combination treatment which ranged from 6.25 - 6.36.

3.1.3 Monitoring Soil Quality Against Cassava Production.

The quality of cassava is seen from the fresh weight of cassava as follows:

Table 3. Fresh weight of tubers after harvest at various fertilization treatments.

No	Treatment	Fresh weight of tubers after harvest (tonnes/ha)i
1	P1	6.95a
2	P2	21.56bc
3	P3	21.56bc
4	P4	18.91bc
5	P5	21.64bc
6	P6	16.09b
7	Q7	19,14bc
8	Q8	19.53bc
9	Q9	20,16bc
10	P10	24.06c
		19,22bc

Note:
1. Numbers with the same notation in the same column are not significantly different
2. Code of Treatment
P1 : Control P6 : Compost 10 ton/ha
P2 : Urea Fertilizer P7 : Urea Fertilizer + P. Cages 5 tons/ha
P3 : Urea Fertilizer + SP36 P8 : Urea Fertilizer + Compost 5 ton/ha
P4 : Urea Fertilizer + SP36 + Kcl P9 : Urea Fertilizer + SP36 + Compost 5 tons/ha
P5 : Manure 10 tons/ha P10 : Urea Fertilizer + Blotong 5 tons/ha

3.2 Discussion

From the results of the study it was found that the use of organic fertilizers (organic fertilizer alone or a combination thereof) can improve the physical and chemical quality of the soil in the form of a decrease in soil unit weight (20.87%), an increase in soil porosity (27.69%), an increase in soil aggregate stability (131.97%), increased soil permeability (201.72%), increased organic matter content (107.94%) and nutrient availability of N (61.90%) and increased CEC (50.53%) compared to control.

Besides that, the fertilization treatment (organic and inorganic fertilizers) had a significant effect on cassava yields. Combination fertilizer treatment gave better cassava yields compared to only organic and inorganic fertilizer treatments. P9 combination fertilizer treatment (Urea Fertilizer + Sp36 + Compost 5 tons/ha) gave the best fresh weight yield with an increase of 289.87% compared to the control. When compared to the previous year, in the fifth year it showed a decrease in fresh weight, especially in treatment P1 (Control). In treatment P9 (Urea Fertilizer + SP36 + Compost 5 tons/ha) the highest total N-value was obtained due to the addition of N elements both in the form of nitrate to the soil. The nitrogen comes from the decomposition of organic matter and urea.

The results of observations of soil quality parameters presented in Tables 6 and 7 show that after 5 years of planting cassava, several soil quality parameters have significantly changed. In the treatment without tillage and fertilization, all soil quality parameters observed in this study decreased. The results of the Duncan test showed that the control had a significantly different organic matter content and was the lowest compared to other fertilization treatments. The organic matter content in the Control was 0.89%.

4. CONCLUSION

Based on the results of this study, several conclusions can be drawn, including the use of organic fertilizers (organic fertilizers alone or their combination) in general can improve the physical and chemical quality of the soil in the form of a decrease in soil bulk density (20.87%), an increase in soil porosity (27.87%), 69%), increased soil aggregate stability (131.97%), increased soil permeability (201.72%), increased organic matter content (107.94%) and N nutrient availability (61.90%) and increased CEC (50 .53%) compared to the control and the fertilization treatment (organic and inorganic fertilizers) had a significant effect on cassava yields.

Combination fertilizer treatment gave better cassava yields compared to only organic and inorganic fertilizer treatments. P9 combination fertilizer treatment (Urea Fertilizer + Sp36 + Compost 5 tons/ha) gave the best fresh weight yield with an increase of 289.87% compared to the control. When compared to the previous year, in the fifth year it showed a decrease in fresh weight, especially in treatment P1 (control) and in general the use of organic fertilizers and combinations with inorganic fertilizers had a better effect on several parameters of soil quality and production when compared to only the use of inorganic fertilizers just.

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It is necessary to carry out further research regarding the effect of various fertilization treatments on soil properties and cassava yields in the following year with the right application time and the use of organic fertilizers as soil amendments is more effective if balanced with the addition of inorganic fertilizers to further increase its benefits in improving soil quality in fast timeframe.

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