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Tracking the fate of organic matter residue using soil dispersion ratio under intensive farming in red acid soil of Lampung, Indonesia

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SUMMARY

Organic matter or compost which applied to the soil can improve soil physical properties, such as forming microaggregates and increasing soil water holding capacity. However, the effect and the sustainability in the soil depended on the type of organic matter origin and its composition as well as its environment. This study aims to determine the fate of organic material , which is mainly its composition from cowdung using simple tools, soil dispersion ratio (DR). A soil survey was done to the area with different land use and organic matter (compost) application . The area with no compost application (0 t ha^{-1}) including in cassava, oil palm, and pineapple (3 locations), while area with banana and guava applied with compost around 50 t ha^{-1} - 100 t ha^{-1} and pineapple with 180 t ha^{-1} . The experiment showed that the soils were generally categorized as moderately to extremely dispersive, except cassava was little dispersive. Clay particles were mostly binded by organic material by the mechanism of cation brigde, and contributied >50% of clay aggregate form, and the highest one was in cassava .

Introduction

In humid tropical area of Lampung, Indonesia, Red acid soil are dominat, which generally have low nutrient content and soil organic carbon due to intensive leaching and rapid decomposition processes. Organic matter or compost application is mostly recommendation to improve soil fertility in the humid tropics climate.

Tisdall and Nelson (1982) pointed out that the organic binding agent could be (a) transient, mainly polysaccharides, (b), temporary, roots and fungal hyphae, and (c) persistent, resistant aromatic components associated with polyvalent metal cations, and strongly sorbed polymers.

Watanabe (2017) showed that continuous application of cattle manure could stabilize soil organic matter such as in the form of structural alterations, occlusion in soil aggregates, and adsorption to clay minerals, preserved soil organic matter derived from cattle manure.

Due to the fact that clay particle will bind carbon organic component though electrostatic binding or cation bridge (“forming pseudo sand”), a comparison between clay particles and “pseudo sand” particles could be used to evaluate the effect of organic carbon to the soil. This concept which known as dispersion ratio was introduced by Middleton (1930). By comparing comparing dispersed soil partiles with undispersed soil particles, estimation of clay particles which was binded by organic carbon (“pseudo sand or micro aggregate”) could be estimated.

This research aimed to evaluate residue of organic matter which mainly consisted of cow manure in pineapple plantation under various amount of application as well as crop rotation.

Material and Method

This research was carried out in at Terbanggi Besar, Central Lampung, Indonesia. Soil survey was done to the area with different land use and organic matter (compost) application in which the compost was 90% consisted of cow dung. The area which no compost application (0 t ha^{-1}) including cassava, oil palm, and pineapple with different age 3,6,9 months,6,9,and 15 months(harvest area), while area with banana and guava applied with compost 50 t ha^{-1} - 100 t ha^{-1} and one pineapple area with 180 t ha^{-1} (code :pineapple 11). Each location was taken 4-5 soil sample with distance 25-50 m, analysed separately as replications. The compost were applied 6-8 months previous to soil sam pling.

The soil dispersion ratio (DR) was defined :

$$\frac{\text{Percent silt+clay Undispersed}}{\text{Percent silt+clay dispersed}} \times 100\ \% \qquad (1)$$

The percentage of silt and clay in dispersed form were analysis using texture analysis with the addition of Calgon + H_2O_2 + distilled water, while only distilled water was used to get undispersed fraction. Soil texture analysis was carried out using the hydrometer method.

The classification of dispersion ratio was according to Elges (1985) which was as followed : dispersion ratios > 50% (extremely dispersive), 30%- 50% (moderately dispersive), 15% -30%(a little dispersive) and < 15% (non-dispersive).

The calculation of clay fraction that binded by organic carbon could be dvided into two forms (1) binded using "glue mechanism" (2) binded by "cation brigde" mechanism", which were calculated as follows :

Clay-glue mechanism (Cg)

$$Cg = Silt_{undispersed} - silt_{dispersed} \qquad (2)$$

Clay cation bidge mechanism (Cc)

$$Cc = Sand_{undispersed} - Sand_{dispersed} \qquad (3)$$

So total partices clay that becomes "aggeregate" (Cag)

$$C\ ag = Cg + Cc \qquad (4)$$

Result and Discussions

The basic soil properties which were listed in Table 1 showed that experiments sites were dominated by clay and sand fraction which the soil texture from sandy clay to clay, with clay is dominant.

Table 1.Basic soil properties in the experiment site

Land use	Texture class*	Clay	Silt	Sand	C-organic
			%		
Banana-1	SC	45.4	7.7	46.9	1.31
Banana-2	SCL	35.3	7.5	57.2	1.06
Cassava	C	53.6	7.6	38.8	1.25
Guava-1	SCL	34.0	8.5	57.5	1.34
Guava-2	SC	38.5	8.0	53.4	0.31
Oil Palm	C	49.2	10.1	40.7	0.88
Pineapple (3)	C	52.2	5.9	41.8	0.57
Pineapple (6)	C	46.1	7.5	46.4	0.57
Pineapple (9)	C	46.9	12.7	40.4	0.77
Pineapple(11)	C	50.1	6.5	43.4	1.57
Pineapple(15)	C	46.4	15.5	38.1	1.08

*C: clay; S:sandy; L : loam

The soil carbon organic were low, less than 2%, some even less than 1%, except in pineapple with 180 t/ha compost was 1.57%. With low soil carbon as well as low of kation base in Ultisol soil, the soil aggregation would be very weak

The experiment showed that the soils were generally categorized as moderately to extremely dispersive, except cassava was little dispersive (Fig.1). Although guava and banana had high compost application, the dipersion ratio falled to extremely dispersive, while pineapple with no compost only have moderately dispersive.

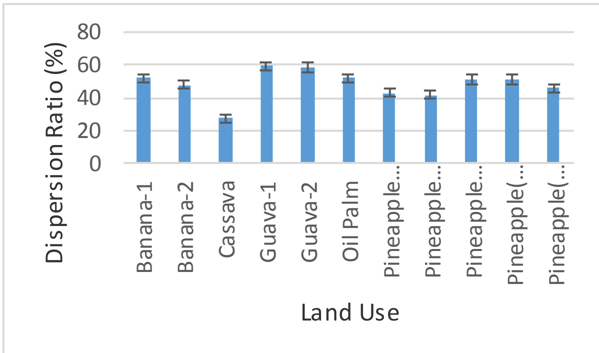

Fig 1. Dispersion ratio from various land use

The lowest of DR was found in cassava land use., which was usually manage with minimum tillage and management. Rasheed (2016) got that the DR value from bare soil with lowest organic matter (1.1%) was only13%. Lipiec et al. (2018) showed that the amount of readily dispersible clay was also effectec by the deformation level of the soil, which was increase in strongly compacted soil and positive correlations with bulk density.

High dispersion showed that there is binding between soil particles with the binding agency, and the binding are not strong. To see the mechanism of "glue" or "cation bridge" mechanism, the equation (2) and (3) were used to calculate from each contribution. The resultas were shown in Table 2.

Table 2 showed that clay particles were mostly binded by organic material by the mechanism of cation brigde, and contribution were above >50%, and the highest one was in cassava land use with 88% value

Table 2. Percentage of clay in silt and sand fraction

Land use	Cc	Cg	Cag	Cc/Cag	Cg/Cag
			%		
Banana(1)	22	20	41	52	48
Banana(2)	22	10	32	70	30
Cassava	44	6	50	88	12
Guava(1)	19	16	36	54	46
Guava(2)	20	12	32	63	37
Oilpalm	28	17	46	62	38
Pineapple(3)	33	16	49	67	33
Pineapple(6)	31	11	43	73	27
Pineapple(9)	29	14	43	69	31
Pineapple(11)	28	21	48	57	43
Pineapple(15)	33	12	45	74	26

However, the dispersion ratio (Fig.1) showed that the most of soils were categorized as moderately to extremely dispersive that "the bridging cation" were not enough or low to make strong aggregation between soil organic carbon and clay particles. The low cation bases in Ultisol probably the main cause that the micro aggregate built was not strong enough. Baohua and Doner (1993) stated that in the absence of polyvalent cations, negatively charged such as humic acid, may not contribute to stable soil aggregation**.** The effect of exchangeable cation to clay dispersion, such as Na, Fe, OC, Mg, and and Al, as well as Mg, were also shown by .Igwe et al. (2006).

The "glue mechanism" which form "silt undiepersed fraction" contribute significantly in high compost application, such as in banana, pineapple (11) and guava

Conclusion

The soil were dominately by clay fraction, however , the DR was moderately to extremely dispersive . The binding mechanism were mainly in sand fraction, using cation bridge mechanism, however, it is not strong enogh due the low of soil organic carbon as well as polyvalent cation in red acid soil. The application of high compost with dominated by cowdung material only gave "glue binding mechanism" which aggregated in silt pool.

Acknowledgement

The authors thanked to PT. Great Giant Pineapple. Central Lampung. Lampung. Indonesia, for facilitating this research.

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Effects of Waterlogging on Pineapple Growth and Soil Properties on Red Acid Soils of Lampung, Indonesia

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SUMMARY

Red acid soils in humid tropic generally have high rainfall in this area. Including acid soils in Indonesia, the average annual rainfall more than 2000 mm which occurred in the rainy season for six months. Mismanagement of excess water will adversely affect the growth of plant. Waterlogging occurs when the amount of rainfall exceeded the infiltration of water in the soil. This is the main problem especially for pineapple plant because this plant cannot survive long in conditions of waterlogging for a long period. This research want to know the effect of waterlogging on soil chemical properties and the second, to know the pineapple resistance to waterlogging, and its effect on the growth of pineapple root. This experiment was conducted at the location of Research and Development (R&D) PT Great Giant Pineapple (PT GGP), Lampung, Indonesia along 2 months, from August to October 2016. The experiment design was arranged in completely randomized design with three replication. Waterlogging treatment is treatment by adding water into the polybag until saturated and let the water flooded up to 2 cms from soil surface. There are 6 treatments: W0: no waterlogging (maintain soil humidity in field capacity) (control), W24: waterlogging 1x24 hours, W48: waterlogging 2x24 hours, W72: waterlogging 3x24 hours, W96: waterlogging 4x24 hours, W120: waterlogging 5x24 hours. The research showed that waterlogging 1x24 hours can increased soil pH and decreased exchangable aluminium in the soil significantly different, the second, waterlogging can increased iron in the soil and significantly different on 5x24 hours and the third, waterlogging star 2x24 hours can inhibit root growth of pineapple

Introduction

Red yellow podzolic is an acid soil that spread very wide in Indonesia which was almost occupied 30% of Indonesian's soil. Red yellow podzolic is found in all parent materials such as vulcanic tuff, granite, sandstone and andesite (Buurman, 1980). The high rainfall on this soil can cause waterlogging. Waterlogging has both direct and indirect effects on plant growth and production. The effects on plants will be more serious if salinity occurs in the soil, if both occur simultaneously it can cause the production will decrease drastically (Singh, 2015).

Waterlogging can inhibit plant growth of pineapple. Iron toxicity can occurs only in waterlogging soil that has in a long period of time, by lowering the redox potential of the soil causes the Fe^{3+} on mineral soil is reduced to Fe^{2+} is more soluble in water, caused iron concentration reached 1000 mg l-1 (Kirk, 2004). The amount of ferrous (Fe^{2+}) in the soil solution can caused nutrient imbalances which affect plant growth (Audebert, 2006). Plants with a high iron content is characterized by stunted growth, leaf spot rusted, stained leaf edge, and a poor root system. In some cases, it can lead to the death of plants and lower yields of up to 100% (Sahrawat, 2004), depend on cultivar tolerance, resistance to stress, and field management (Audebert and Fofana, 2009).

The aim of this research to investigate the effect of waterlogging on the growth of pineapple root.

Materials and Methods

This experiment was conducted at the Research and Development (R&D) site of PT GGP, Lampung, Indonesia. The texture of the soil is sandy clay with particle sizes of 52.4% sand, 2.6% silt and 45.0% clay. The soil properties prior to planting are shown in Table 1. Seed materials were used from crown of pineapple.

The experiment design was arranged in completely randomized design with three replication. The weight of the soil used was 10 kg in polybag. Waterlogging treatment is treatment by adding water into the polybag until saturated and let the water flooded up to 2 cms from soil surface. There are six treatments, W0: no waterlogging (maintain soil humidity in field capacity/control), W24: waterlogging 1x24 hours, W48: waterlogging 2x24 hours, W72: waterlogging 3x24 hours, W96: waterlogging 4x24 hours, W120: waterlogging 5x24 hours**.**

Table 1 Selected characteristic of soil

Property	value
pH	4.26
Total C (%)	1.32
Total N (%)	0.15
C/N ratio	8.80
P (g Kg^{-1})	0.02
K (g Kg^{-1})	0.08
Ca (g Kg^{-1})	0.08
Mg (g Kg^{-1})	0.03
Exc. Al (me 100 g^{-1})	0.61

The treatment were started one month after planting to make sure that the crop were already grown well. Soil chemical analysis was done before and after treatment

Soil properties observation consist of: (1) The pH was determined by using pH Meter, (2) Analysis of K, Ca and Mg was determined by using extraction with ammonium acetic pH 7 and reading with Atomic Absorption Spectrofotometry (AAS). Analysis of iron (Fe) by Mehlich method and aluminium by volumetry method.

Several parameter growth of pineapple growth were measured were (1) root weight, (2) plant of weight, (3) length of leaf

Result and Discussion

Waterlogging can increase soil pH and soil Fe

Figure 1 showed that effect of waterlogging on soil pH significant. On treatment of 1x24 hours waterlogging, the soil pH increase and significant different than control. The highest soil pH on treatment waterlogging 5x24 hours (W120) , and the lowest soil pH on treatment control (W0).

Figure 2 showed that the highest of iron in the soil is on treatment W120. Increased of period of waterlogging tend increase iron in the soil. Audebert (2009) states that poor water conditions can resulting in soil degradation that will increase the accumulation of iron in the soil solution. Silveira (2007) also showed in his research that under waterlogging conditions, the availability of iron would be able to increase and in certain concentrations would cause toxicity in plants. Iron is one of the easier elements to changing in waterlogging condition that from Fe^{3+} to Fe^{2+} (Syafruddin, 2011)

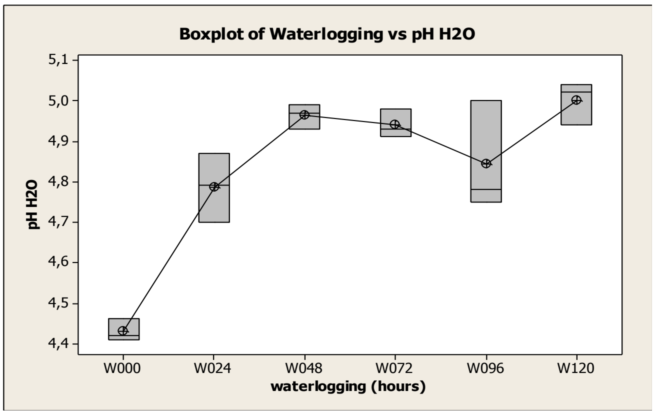

Figure 1. The effect of waterlogging on soil pH

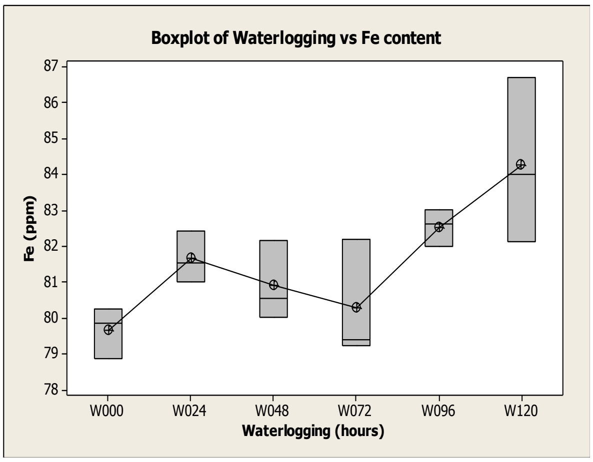

Figure 2. The effect of waterlogging on iron in the soil

Treatment Effect on Al Content in The Soil

Waterlogging can decrease exchangeable aluminum in the soil. Figure 3 showed that the lowest of aluminum in the soil is on treatment W120. Increased of period of waterlogging tend decrease aluminum in the soil. This occurs because increasing in soil pH due to waterlogging. higher pH will cause the availability of aluminum in the soil decreased.

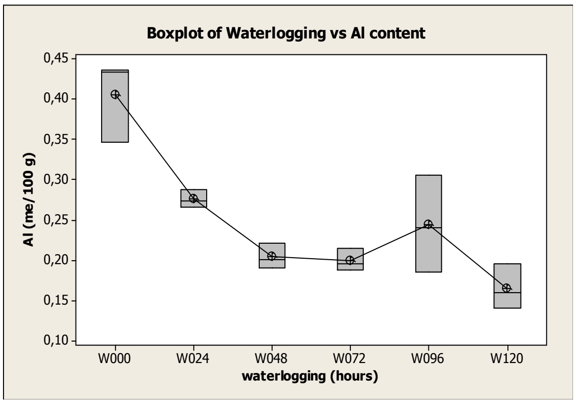

Figure 3. The effect of waterlogging on aluminum in the soil

Treatment Effect on Root and Plant Growth of Pineapple plant

Figure 4 shows that 2x24 hour waterlogging treatment is very severe with roots. This is very different when compared to the control treatment (soil conditions under field capacity). The roots of pineapple plants in field capacity conditions have many roots.

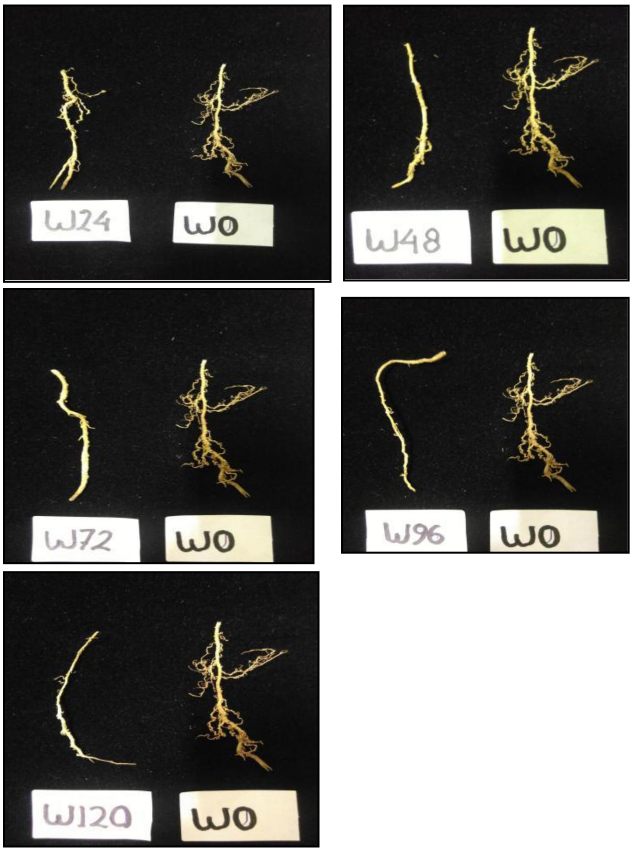

Figure 4. The effect of waterlogging on root growth of pineapple

The root weight of the control treatment was highest compared with the waterlogging treatment (Figure 5). This shows that standing water can inhibit the growth of pineapple plant roots. This is in line with Singh (2015) opinion that waterlogging was harmful and may affect plant growth because soil in the waterlogged condition can reduce soil aeration around the root zone so that root growth will be stunted.

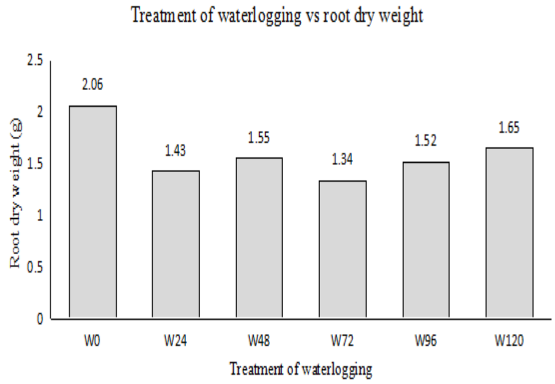

Figure 5. The effect of waterlogging on root dry weight of pineapple plant

Pineapple tolerant in waterlogging condition maximum until 2x24 hours. Figure 6 showed that the gain growth of plant weight after waterlogging 1x24 hour, occur decrease the gain growth of plant. The highest is on treatment W24 and after this is on treatment W48 lowest. Treatment of W72 and W96 are also give the low but on treatment W120 higher than W0.

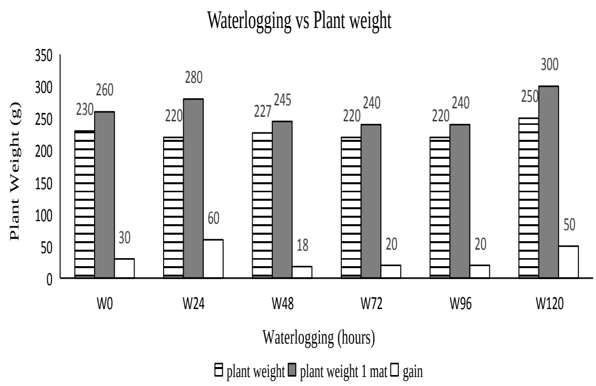

Figure 6. The effect of waterlogging on plant weight of pineapple plant

Conclusion

Waterlogging 1x24 hours can increased soil pH and decreased exchangable aluminium in the soil significantly different, the second, waterlogging can increased iron in the soil and significantly different on 5x24 hours, the third, waterlogging start 2x24 hours can inhibit root growth of pineapple

Acknowledgment

The authors express their gratitude to Management of PT Great Giant Pineapple, Lampung, Indonesia, for the all supporting from location and materials of experiment.

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Effects of aluminum stress on shoot growth, root growth and nutrient uptake of three pineapple smooth cayenne clone [*Ananas comosus* (L.) Merr.]

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SUMMARY

Aluminum (Al) is a biotoxic metal to most of plants which inhibits root growth, led to a series of influence metabolic abnornal and becomes the main limiting factor productivity in acid soils. In this experiment, effect of Al strees on plant growth, root growth, macronutrient uptake (N, P, K, Ca, Mg) and Al uptake in root and plant were studied. Three pineapple crown of smooth cayenne clones (GP1, GP3 and F180) was cultured from 0 to16 weeks in aquadest culture medium that contain 6 level of Al concentration treatment 0, 100, 200, 300, 400 and 500 μM $AlCl_3$. Experiments using a factorial randomized block design with 5 replications in a greenhouse growing environment. Results of this experiment showed that the three clones have a different response of tolerance to Al stress. GP3 clone showed the highest growth in the number of leaves, number of seminal roots, production of roots sugar, P leaf uptake and the lowest roots uptake of Al compared to other clones. GP1 clone produce the highest root length, percent of weight vertical root, and K leaf uptake. While F180 clone produces the highest water volume uptake of roots, weight of fresh roots, weight of plant, leaf uptake of N, Ca and Mg, and the lowest Al toxicity morphology than other clones. For the optimal balance proportion of plant and root growth, we can be said that F180 and GP3 clones have high levels to Al toxicity tolerance for that can growth well for acidic soils that have low pH.

INTRODUCTION

Pineapple [*Ananas comosus* (L.) Merr.] is one of the main plantation crop commodity in the world after bananas and oranges (Bartholomew et al., 2003). Generally, the pineapple is cultivated in the area 30 ° North latitude to 30º South latitude, with a temperature of 20-30 ºC, and variations in photo-periodism 10-12 hours. Pineapple is reported have adaptability at low pH soils containing high Al and Mn (Bartholomew, 2005).

The primary effect of Al toxicity is the inhibition of root growth; however, the mechanisms involved in this toxicity are far from clear (Matsumoto 2000).

Nutrient absorption and cell function will be impaired after exposure to high concentrations of Al. Root tip is the area where Al and interact root, root cell walls have a mechanisms to protect the entry of Al into the roots. Root cell walls are formed of a material that is negatively charged pectin that serves to attract cations. When the root tip saturated by Al, uptake of nutrients such as K^+, Ca^{2+}, Mg^{2+} and NO_3 will decline to enter the root cell walls. If the bond is excessive Al appeared between Al and the cell walls of root, root growth is inhibited (Lin and Chen, 2011).

Although aluminum toxicity can be ameliorated by surface application of lime, this is often not economically or physically feasible. Hence, combining the use of Al tolerant cultivars with liming is often the most effective strategy for improving crop production on acid soils. Several screening methods have been employed for this purpose, from genotype screening in the laboratory to soil bioassays and field evaluations (Hede et al, 2001). This study was conducted to examine the effects of six different Al concentration on plant growth, root growth and nutrient uptake of root and leave of three pineapple smooth cayenne clones [*Ananas comosus* (L.) Merrill] in strongly acid environment.

MATERIALS AND METHODS

Seed material used pineapple of three clones from smooth cayenne cultivar, namely GP1, GP3 and F180, which is derived from pineapple plantation location in PT Great Giant Pineapple, Terbanggi Besar, Central of Lampung, Lampung, Indonesia. Seedlings were selected from crown seed which have fresh weight 200-350 gr (medium size seed for cultivation). After cleaning with deionized water, these seeds were cultivated in tin-coated plastic container (15 cm inner diameter and 10 cm height) which contain 500 ml of distilled water were treated with $AlCl_3.6H_2O$ appropriate level of Al toxicity (0, 100, 200, 300, 400 and 500 μM $AlCl_3$). Plants planted in a greenhouse environ-ment. $AlCl_3$ solution was added every 1 week to replace the water that is absorbed by the roots reaching back to 500 ml. Climate condition during the experiment was daylight temperature 31.4 – 33.9 °C, night temperature 21.6 – 23.2 °C, and relative humidity 85.0 – 91.3%.

Experimental design used randomized block design factorial (3x6) with 5 replications. Factor 1, pineapple smooth cayenne clones, consists of three clones : GP1, GP3 and F180. Factor 2, $AlCl_3$ concentration in the water culture solution, consists of 6 levels $AlCl_3$ concentration : 0, 100, 200, 300, 400 and 500 μM.

Shoot growth observation

Pineapple shoot growth parameters which measured were (1) plant height (2) length of D-leaf, (3) plant weight at 16 weeks after planting.

Root growth observation

Root growth parameters which measured were (1) the length of the (2) the amount of seminal roots, (3 the volume of water absorption by roots (4) fresh and dry plant weight (5) percentage of vertical root, (6) total sugar roots production

Observation of leaf and root nutrient uptake

The content of N, P, K, Ca, Mg and Al leaves were measured at 16 weeks after planting for composite samples of roots and leaves.

RESULTS AND DISCUSSION

Effect of $AlCl_3$ concentration on shoot growth

Figure 1 shows the effect of $AlCl_3$ concentration on the growth of plant height, length of D-leaf, number of leaves, and plant weight. Shoot growth tend decrease with increasing $AlCl_3$ concentration in the solution. F180 clone showed the highest of plant height (Figure 1), length of D- leaf (Figure 2), and plant weight (Figure 3) compared to the other clones. GP3 clone showed the best of number of leaves growth In addition, GP3 clone also did not show a decrease in plant weight at the higher $AlCl_3$ concentration in the solution.

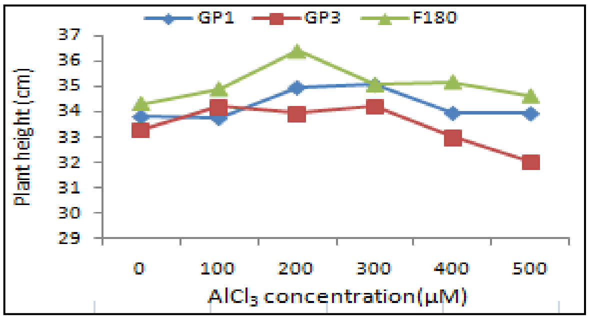

Fig.1. Effect of $AlCl_3$ on plant height

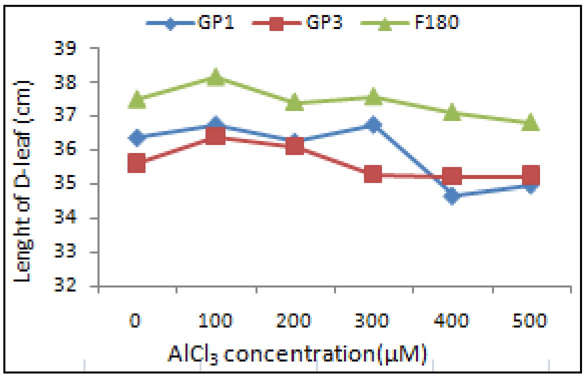

Fig.2. Effect of $AlCl_3$ on D-leaf length

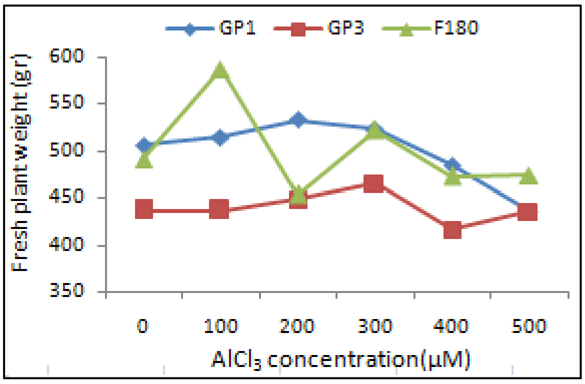

Fig.3. Effect of $AlCl_3$ on plant weight

Effect of $AlCl_3$ concentration on root growth

Root growth tend to decrease with increasing $AlCl_3$ concentration in the solution as seen in the root length (Figure 4), the number of seminal roots (Figure 5), fresh weight roots (Figure 6), percentage of vertical root weight (Figure 7).. Each clone showed a different root growth response to Al stress. GP1 clone shows the best growth of root length and percentage of vertical root weight especially in high Al stress (> 300 μM $AlCl_3$). While the best number of seminal root on Al stress at 500 μM $AlCl_3$

seen in GP3 clone (Figure 5) and F180 clone showed the highest fresh root weight in the Al highest stress

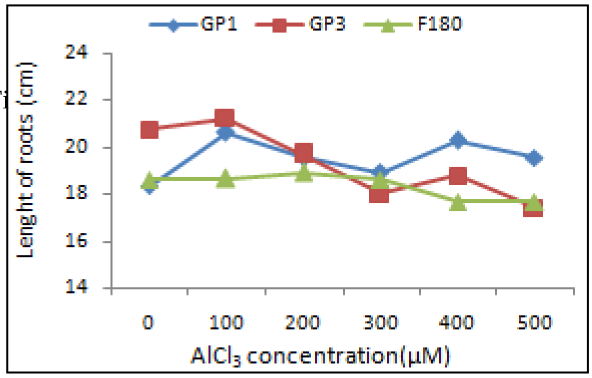

Fig. 5.Effect of AlCl3 on root length the root length

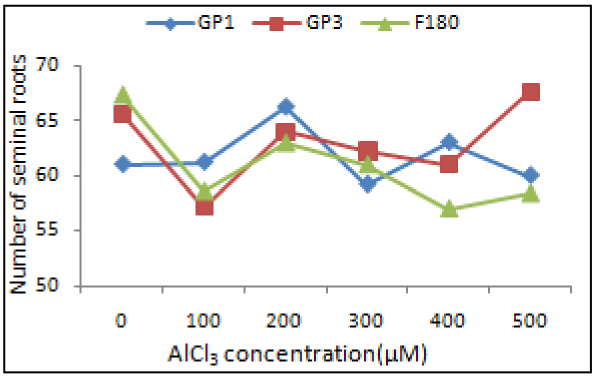

Fig. 6.Effect of AlCl3 on the number of seminal roots

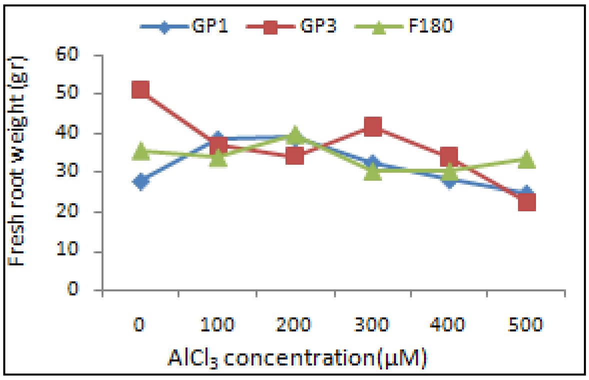

Fig. 7 .Effect of AlCl3 on fresh weight roots

Nutrient uptake by leaf

Ca and Mg leaf nutrient uptake nutrient uptake with the higher $AlCl_3$ concentration in the solution. concentration. This is similar to study Lin and Chen (2011) which states that the decreased uptake of Ca and Mg with increasing concentrations of $AlCl_3$. Increasing Ca and Mg uptake become an important indicator of the ability of the plant to reduce the toxicity of Al. Ca and Mg root uptake remain high in GP3 and F180 clones at high Al stress indicates that both these clones have a degree of tolerance to Al toxicity better than clone GP1.

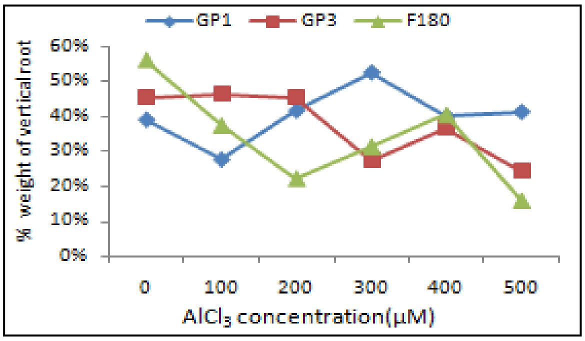

Fig. 8 .Effect of AlCl3 percentage of vertical root

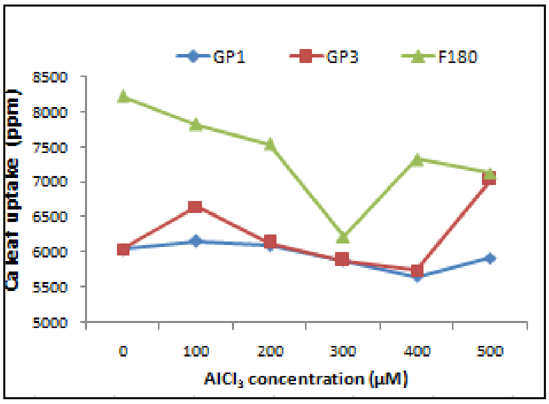

Fig. 9.Effect of AlCl3 on Ca upatke.

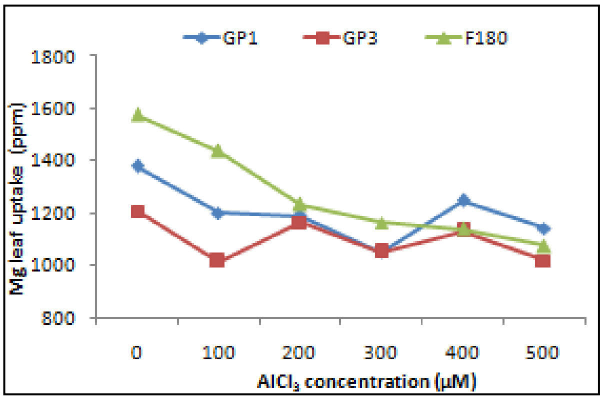

Fig. 10.Effect of AlCl3 on Mg uptake

CONCLUSION

In the Al high stress (500 µM $AlCl_3$), GP3 clone still show the best growth in the number of leaves, number of seminal roots, Tolerance of GP1 clone is shown in the best root length, percentage of weight vertical root. While F180 clone shown the best in root volume water uptake, fresh weight root, fresh weight plant, leaf uptake of N, Ca and Mg. In other word, we can said that F180 and GP3 clones are clones that have good adaptability to grow well under conditions of stress Al.

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The effect of long-term cassava cultivation on organic carbon content and soil physical properties in Central Lampung

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SUMMARY

The effect of long-term cassava cultivation on organic carbon content and soil physical properties in Central Lampung has been investigated. A plot of land that had been cultivated for Cassava plants and another plot for mixed garden for more than 30 years were studied in order to know how the effect of of long-term cassava cultivation on organic carbon content and soil physical properties. The results show that long-term cultivation of cassava had reduced the thickness of the surface layer and organic carbon content, changed soil color become lighter and changed the shape of soil structure in the soil surface layer from crumbs become angular blocky. There was a tendency that the bulk density and the soil strength in cassava cultivation were lower in the surface layer and higher in the bottom layer.

Introduction

Cassava *(Manihot escu/enta* Crantz) *(Manihot escu/enta* Crantz) is an important agricultural commodity for Lampung Province. In 2015, Lampung Province had contributed 34% of national cassava production (BPS, 2015). Cassava could performs best in soils of friable nature to permit expansion of tubers (Nnaji, 2009), however, it is very tolerant of various soil conditions even in marginal soils which for other food crops are difficult to grow properly

Cassava is usually grown by farmers in the tropics with a minimum of inputs, and continuous production under these conditions can lead to soil nutrient depletion. On sloping land, cassava cultivation can also cause severe erosion if the crop is not properly managed (Howeler, 1991). Cassava is increasingly attractive as an energy crop due to its high rate of CO_2 fixation, high water-use efficiency, high carbohydrate content, and superior starch conversion ratio for ethanol compared to other crops (Kristensen *et al.*, 2014).

Many people are convinced that cassava production leads to soil degradation, and some governments do not encourage cassava cultivation in the belief that it causes serious erosion and nutrient depletion (FAO, 2014).Cassava is grown throughout the tropics on a great variety of soils, but is mainly found on Ultisols, Oxisols and Entisols, which are generally characterized by low soil fertility. In many parts of the tropics it is grown on the poorest soils, such as on eroded slopes or extremely sandy soils, where it produces something whereas other crops would not. This ability has led many to think that cassava does not require high soil fertility nor responds to fertilization (Howeler, 1991).

This study aims to determine the effect of long-term (> 20 years) cassava cultivation on organic carbon content and soil physical properties compared to mixed garden in Central Lampung.

Materials and Method

This research was conducted on land that had been cultivated with cassava plants for 30 years in the Central Lampung, Sumatra. For comparison, a land that was planted with various trees on coffee base was chosen, and this land system was called mixed garden (MG). Both types of land use have the same land characteristics such as slope (3-4% gentle slope), acid tuffs parent materials (Mangga et al., 1994)), altitude (53 m asl) climate (2205.48 mm rainfall per year), and adjacent locations of around 60 meters.

Each plot of land has an area of about 1 hectare, with a rectangular shape stretching north to south. On each plot of land, three mini profiles are determined and made at the top of the slope, the middle of the slope and at the bottom of the slope. The soil profiles were described according to the Manual Survey Soil (1993) and then the soil samples were taken in the middle of soil layers, both undisturbed soil samples using sample rings and disturbed soil samples. Soil Strength of each soil layer was determined in the fields by using Pocket Penetrometer. Soil samples analyzed include organic carbon (Walkley and Black), soil texture (Bouyoucos), bulk density. Then data of three profiles were averaged.

Result and Discussion

3. 1 Soil Morphology and Texture

After more than 30 years of cassava cultivation (C), it was seen that there were differences in surface layer thickness, soil color, and soil structure shape and soil organic matter content (Table 1). Accumulation of litter from dead leaves and then decomposition has led to higher organic carbon content in mixed garden (MG) . Meanwhile on cassava cultivation land which is rarely applied by organic matter and crop residues not returned to the land has caused lower organic carbon content. In addition, the more open land from the beginning of post-harvest, tillage, the beginning of planting until the next 3 months makes conditions conducive to the ongoing process of oxidation of soil organic matter and erosion. As a result, the thickness of the surface layer on cassava cultivation land is reduced.

The amount of soil organic matter is very influential on the color of the soil, making the color of the soil darker, this is indicated by the color of the soil on darker natural veg land (lower value and chroma) compared to cassava cultivation. Reduced soil organic matter on cassava cultivation has caused changes in the shape of the soil structure from crumbs to angular blocky. Another possibility that can change the shape of the structure in the surface layer is the loss of the surface layer so that the existing surface layer is actually the lower horizon that appears on the surface.

The consistency of soil is strongly influenced by the shape and size of the particles (Baver, 1956) and the type of clay minerals. Because the soil texture on both types of land is not much different (Table 2) and is predicted to have the same type of clay minerals, the consistency of the soil of the two types of land is the same, which is friable in the surface layer and firm in the lower layers (Table 1).

Bulk density in both types of land is not much different (Table 2). On cultivated land for cassava plants, soils is always ploughed before planting so that the soil surface layer is more nested (lower bulk density). Therefore, even though the content of organic matter in cassava cultivation land is lower than natural vegetated land, it has a slightly lower bulk density value. This is supported by the value of the soil strength which is also slightly lower. On the second layer, the opposite happened that bulk density on cassava cultivation land was slightly higher than mixed garden land, this was supported by the soil strength value and also its higher clay content. The higher content of clay in the lower layers of cassava fields is related to the higher leaching processes of clays due to the opening of the canopy.

Table 1. Soil Morphology

Land Use	*Layer*	*Layer Thickness*	*Color*	*Stru*	*Cons*	*C-org*
		cm				%
C	I	9	10 YR 3/3-3/4	ab	fr	1.54
	II	17	10 YR 5/6-5/8	ab	fi	0.85
MG	I	17	10 YR 2/2	cr	fr	3.09
	II	16	10 YR 4/4-4/6	ab	fi	1.21

*)Stru: Structure: ab (angular blocky),cr:crumb

**)Cons: Consistency: fr:friable; fi:firm

Table 2. Soil Physical Properties

Land use	*Hor*	*%*			*Bulk Density*	*Soil Strength*
		sand	silt	clay	g/cm3	kgf/cm²
C	A	29.3	11.7	59.0	1.16	0.91
	B	18.9	9.5	71.6	1.22	3.09
MG	A	33.2	17.6	49.2	1.22	0.93
	B	21.6	12.2	66.2	1.16	2.89

Conclusion

Long-term cultivation of cassava results in reduced thickness of the surface layer and organic carbon content, the lighter color of the soil, and changes in the shape of the soil structure in the soil surface layer from crumbs to angular blocky.

Although it is not much different, but there is a tendency that the bulk density and the soil strength in cassava cultivation land are lower in the surface layer and higher in the bottom layer.

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Corn Yield and Soil Properties under longterm conservation tillage in clayey soil tropical upland of Lampung, Indonesia

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SUMMARY
The conservation tillage system which includes minimum and non-tillage tillage becomes an alternative land preparation that can maintain high productivity. One thing that determines the success of conservation tillage is to restore plant residues after harvest as a source of organic material in the form of mulch to maintain the physical properties of the soil. This study aims to determine the effect of tillage and nitrogen fertilization systems on the soil prorerties and corn yeild. The study was conducted using a Randomized Block Design (RBD) which was arranged factorially with 4 replications. The first factor is a long-term tillage system (T1 = Intensive tillage, T2 = Minimum tillage, T3 = No tillage) and the second factor was long-term nitrogen fertilization (N0 = 0 kg N ha^{-1} and N1 = 200 kg N ha^{-1}). The data obtained will be tested for homogeneity by the Bartlet test and the additivity of the data was tested by the Tukey Test. The results showed that long-term tillage and fertilization systems did not affect the physical properties of the soil, namely bulk density, soil porosity, soil texture, and soil structure. The highest soil organic carbon was obtained when the treatment of the minimum soil combined with of 200 kg N ha^{-1} treatment was 1.56%. The highest corn yield was obtained from the treatment of the minimum tillage and no tillage combined with nitrogen fertilization of 200 kg N ha^{-1}.

Introduction

Lampung Province, Indonesia, is one of the largest corn producing provinces in Indonesia. In 2017, Lampung was ranked as the third corn producer in Indonesia after East Java and Central Java, in which Lampung contributes 8.59% of corn production. In 2016 corn production was 1.7 million tons, while in 2017 Lampung corn production increased to 2.4 million tons.

Dry land is one of the natural resources that has the potential to increase agricultural production in Indonesia. However, this potential area has not been used optimally. Constraints that are often encountered on dry land include low soil fertility, high erosion and drought in the dry season (Utomo, et al., 1993). To empower maximum dry land, it is necessary to have suitable cultivation techniques in solving dry land use problems for annual crops. Conservation land is one of the approaches to crop production systems that pay attention to land conservation (Utomo, et al., 1989).

Arsyad (2010) stated that land conservation is relatively more profitable for long-term agriculture, including maintaining or improving soil structure and soil organic matter content, increasing water availability, improving infiltration and reducing environmental damage, and increasing crop yields.

This study aims to find out 1). the effect of conservation tillage on maize (*Zea mays* L.) cropping areas on soil physic property compared to intensive tillage systems, 2). the effect of Nitrogen 200 kg ha^{-1} fertilization on soil physic property in maize (*Zea mays* L.) cropping areas compared to without nitrogen fertilization and 3). interaction between soil tillage systems and nitrogen fertilization on soil physical property in maize (*Zea mays* L.) crop fields.

Material and Methods

This research has been carried out from October 2016 to March 2017 in the 29th year of planting. The study was conducted in the Lampung State Polytechnic experimental garden. The application of long-term tillage conservation and fertilization treatment that has been going on since 1987 (Utomo, 2012).

The study was conducted using a randomized block design (RBD) which was arranged factorially with 4 replications. The first factor is a long-term tillage system, IT = Intensive tillage, MT = Minimum tillage, NT = No tillage, and the second factor is long-term nitrogen fertilization, N0 = 0 kg N ha^{-1} and N1 = 200 kg N ha^{-1}.

Furthermore, the data obtained will be tested for homogeneity with the Bartlet test and data additivity tested by the Tukey Test. If the assumptions are met the data is analyzed by variance, the difference in the middle value of the treatment was tested by the Smallest Significant Difference Test (LSD) at the level of 5%.
The variables observed were bulk density, porosity, soil organic carbon, and corn yeild. Bulk density and porosity analyzed by the gravimetric method.

Results and discussion

Bulk density and Soil Porosity

The results of the analysis of the weight of soil volume and soil porosity (Table 1). Treatment of soil tillage systems and nitrogen fertilization had no significant effect on the weight of soil volume and soil porosity. This is presumably because the mulch that comes from weeds and the residue of plant litter given is too little, which is only 6-8 tonnes ha-1 (Utomo, 2012). To reduce the weight of the soil contents, increase permeability, porosity, and total pore space, the remaining plant mulch is more than 11 tons ha-1 (Brown and Dicky, 1970 in Khair, 2017). Mulyani (2003) states that the application of organic matter from ground cover plants that are immersed in new soil can increase the total porosity of the soil and maintain soil organic matter content and improve the efficiency of inorganic fertilization.

Table 1. Bulk density and porosity at a depth of 5 cm

Treatment		Bulk density ($g\ cm^{-3}$)	Porosity (%)
Soil tillage methode	Nitrogen Fertilization		
IT	0	1.13	57.37
	200	1.13	57.51
MT	0	1.16	56.29
	200	1.22	54.03
NT	0	1.19	55.22
	200	1.18	55.57

Soil Texture and Soil Structure

Soil texture and soil structure in the study area was obtained from previous research. The soil texture in 0-20 cm and 20-40 cm depth for each treatment is clay. In the clay texture, the soil pores will be dominated by micro pores so that water passing through the soil is slower.
The intensive tillage has granular soil structure, while the minimum tillage and no tillage have the same soil structure that are subangular blocky. The stability of the structure and resilience of conservation soil chunks is on average two times higher than intensive tillage. In this case the aggregate is clearly formed and can still be broken down.

Soil Organic Carbon

Soil tillage has a significant effect on soil organic carbon content, while nitrogen fertilizer treatment does not have a significant effect on soil organic carbon (Table 2).

Table 2. Tillage effects and N fertilization on soil organic carbon in

Treatment		Soil Organic
Soil Tillage	IT	1.45b
	MT	1.56a
	NT	1.48b
BNT 5%		0.06
N Fertilizer	N 0 kg ha^{-1}	1.50a
	N 200 kg ha^{-1}	1.50a
BNT 5%		0.05

Using LSD test at 5% level

The minimum tillage has the highest soil organic carbon content which is equal to 1.56% and is significantly different from other tillage systems. This is because in the minimum tillage, weeds and plant residues were previously left on the land, so they can be a source of soil organic matter. This soil surface treatment will facilitate organic matter from mulch weeds and previous plant residues that have been decomposed to enter the soil so that it can increase the soil organic matter content.

Corn Yield

The highest yield of corn was obtained in the treatment of N2T2 and N2T3 while the lowest corn yield was obtained in the treatment of NO3 (Table 3).

Table 3. Effect of soil tillage systems and N fertilization on corn yield

Treatment	IT	MT	NT
N0	4.65c b	5.25c b	2.90d c
N2	5.35c b	7.15a a	6.80ab a
P-value N	1.0131		
p-value T	1.2408		

The treatment of minimum tillage and non-tillage with 200 kg fertilizer Nitrogen ha-1 has the highest corn production compared to others because it has the highest soil organic carbon content and soil permeability compared to other treatments. . The content of soil organic carbon can increase soil fertility so that crop production also increases. Soil organic carbon can also increase the ability of soil to hold water. With the ability of land to hold water, the needs of plants for water are fulfilled to support plant growth and development so that crop production increases.

Conclusion

From the results of this study it can be concluded that Long-term tillage and fertilization systems did not affect the physical properties of the soil, namely bulk density, soil porosity, soil texture, and soil structure. The highest soil organic carbon was obtained when the treatment of the minimum soil combined with fertilizing nitrogen of 200 kg ha^{-1} was 1.56%. The highest corn yield is obtained from the treatment of the minimum tillage and without tillage combined with nitrogen fertilization 200 kg ha^{-1}.

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