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SOIL ORGANIC CARBON IN SOIL FRACTION AND CORN YIELD OF LONG-TERM TILLAGE SYSTEM AND NITROGEN FERTILIZATION

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SUMMARY

Soil Organic Carbon (SOC) in tropical soil is important property for soil sustainability and corn production. Therefore, effort for increasing SOC and corn production in long-term tillage and nitrogen fertilization are important. The aim of this research was to measure SOC content in particle size fraction of long-term tillage systems and N fertilization. Additional aim was to establish the key management to sustain of soil health and corn production. The experiment was a factorial randomized complete block design, with 3 replications. Tillage treatments were No-Tillage (NT), Minimum Tillage (MT), and Intensive Tillage (IT), while N fertilization rate were 0 kg N ha^{-1} (N0) and 200 kg N ha^{-1} (N2). It revealed that, before plowing the long-term conservation tillage, SOC of MT was higher than IT but not different than NT. In our study showed that, both of tillage and N fertilization did not increase SOC in particle size fraction. It was found that, SOC in silt fraction was the highest than other fractions. SOC content in silt, sand, and clay fractions were 1.26%, 0.11%, and 0.10%, respectively. After plowing the long-term conservation tillage, corn yield of N2 was higher than N0. Corn yield in N0 and N2 were 4287 kg ha^{-1} and 6891 kg ha^{-1}, respectively.

INTRODUCTION

To increase corn production we must establish a good management to make soil keep health. Soil management like tillage and fertilization can increase soil production. Utomo (2012) reported that NT and MT could increase the SOC in top soil if followed by high nitrogen fertilization. Quantifying tillage and nitrogen capability to increase SOC will help to evaluate total carbon in particle size fraction. SOC in coarse fraction (sand : 105 -200 μm) was lower than in fine-fraction (silt and clay <20 μm).

The tillage system followed by proper fertilization is expected to increase the storage of SOC in soil particles. Application of a conservation tillage system with mulch and N fertilization are expected to contribute C through the decomposition process and can increase plant biomass. The aim of this research was to determine SOC content in particle size fraction from long-term tillage and N fertilization treatments. Additional aim was to establish the key management to sustain soil health and corn production.

MATERIAL AND METHOD

This research has been conducted in November 2017 until June 2018 (Second year after the plowing of long-term conservation tillage in March 2018). Soil samples were analysed in Soil Science Laboratory, Agrotechnology, Agriculture Faculty, Lampung University. This study was arranged in a factorial randomized complate block design with 3 replications. The first factors were tillage system (No-till; minimum till, intensive till) and the second factors were N fertilization (0 kg ha^{-1}; 200 kg ha^{-1}). Analysis of varience and mean test with HSD 5% were analysed using statistical analysis package.

Soil texture was analysed with Hidrometer's method (Afandi, 2005). The soil fractions were separated with Pipet's method. The clay (<2μm), was isolated by taking soil suspension in the sedimentation tube (±10-20 cm upper the suspention) with a strow (d=0,5 cm). After that, the suspension was put in erlenmeyer and left for 1 week to get the pure clay. While, for isolating of the silt and sand were done with sieved. The size of sieve was 48μm. The soil left under the tube, was sieved and the soil left in the sieve there was sand (2000-48μm), while the soil passed the sieve was silt (48μm- 2μm). The separated fractions was put in *aluminium foil* for air-dried. The air-dried soil sieved again. After that, SOC was analysed with Walkey and Black method.

RESULT AND DISCUSSIONS

Soil

Soil texture were categorized as clay class, with the clay fraction 48-55%, silt 27-33%, and sand 15-22%. The soil of this experiment is Typic Fragiudults (Utomo, 2012).

Soil Organic Carbon (SOC) Before Plowing

Based on analysis of varience (Table 1), SOC was only affacted by tillage system. SOC under MT was higher than IT, but similar to that of NT. It is because in conservation tillage, mulching and slightly tillage increased mulch mineralization, which resulted in higher SOC. While, in IT, tillage increased the SOC decomposition, resulted in less SOC.

This study did not agree with Bojolla *et.al* (2015) finding that there were no different between SOC in conservation and in intensive tillage. It was becauce SOC has reached the balance. Bojolla *et.al* (2015) reported that SOC decreased after 3 years study. SOC would be increased after change from intensive tillage to conservation tillage, but after certain periode the increase was very small becauce SOC has reached the balance.

Table 1. Table 1.Effect of soil tillage and long-term N fertilization on soil organic carbon before plowing

Treatment		Soil Organic Carbon (%)
Tillage System	N (kg ha^{-1})	
No-Till	0	1.49
Minimum	0	1.59
Intensive	0	1.47
No-Till	200	1.53
Minimum	200	1.57
Intensive	200	1.44
Source of Varience		F-calc.
N		0.02^{nt}
T		8.23**
N x T		0.64^{nt}

nt : Not Significantly Different at 5% ; ** : Significantly Different at 1%

Distribution of SOC in soil fraction

This study shown that both of tillage system and N fertilization did not affected the distribution SOC in particle size fraction. But regardless the combination treatments, SOC tended more distributed in silt fraction (Table 2)

Table 2. Effect of soil tillage and long-term nitrogen fertilization on soil organic carbon

Treatment		Soil Organic Carbon (%)		
Tillage System	N (kg ha^{-1})	Sand (2000-48 μm)	Silt (48-2 μm)	Clay (<2μm)
No-Till	0	0.12	1.36	0.11
Minimum	0	0.11	1.27	0.09
Intensive	0	0.10	1.32	0.12
No-Till	200	0.10	1.41	0.11
Minimum	200	0.10	1.42	0.11
Intensive	200	0.15	0.77	0.09
Source of variation			F-calc.	
N			0.05^{nt}	
T			0.16^{nt}	
N x T			0.17^{nt}	

nt : Not Significantly Different at 5%; N : Nitrogen Fertilization; T : Tillage System

In this study, texture tended to affected the SOC. SOC in silt fraction was higher than those of sand and clay fraction (Fig2). Liang *et.al* (2009) reported that size fraction SOC in <20 μm was believed as a stable fraction which resulted higher SOC. He also reported that clay has lost the 55% SOC in intensive tillage. It was because C in the soil has reached the balanced when and SOC was consumed by soil flora and fauna and because of harvest. Different with our studies, however, Udom *et.al* (2015) also reported that clay had a higher SOC than the other. In our study shown that silt had a highest SOC. It was because the different between climate and clay mineralogy (Liang *et.al,* 2009).

Clay of 1:1 and 2:1 have different impact on SOC. Liang *et.al.* (2009) reported that soil in their study contained a lot of clay 2:1 so this clay did not really impact the SOC. The high temperature, lower rain-fall and lower organic matter were the reason why clay contained lower SOC.

In our study, silt cointaned higher SOC was because the character of silt as "*medium-term sink"* (Gerzabek *et.al.,* 2001, Barbera *et.al.,* 2010). But, silt has a meso-pore higher than clay so that silt can not retain C strongly. It was indicated that with long-term intensive tillage, the loss of SOC in silt fraction will be higher. Andita (2018) reported that intensive tillage could increased organic matter decomposition and resulted in decreased of soil organic carbon and humic acid.

While in treatments combination of tillage and N fertilization, silt of all combination of tillage and N fertilization contained SOC of 86-88%, except combination of IT and 200 kg N ha^{-1} that only contained 76 % SOC . It was because intensive till had a higher O_2 that could cause decomposition SOC more faster. On the other hand, N fertilization caused the fastest decomposition of SOC.

Corn Yield

Based on Anova (Table 3), corn yield was only affacted by N fertilization treatment. N fertilization of 200 kg ha^{-1} had higher corn yield than without fertilization. It was because the function of N is to establish amino acid and to arrange the nucleat acid (Muzammil *et.al,* 2012). This response was an indication that the soil was lack of available N.

Table 3. The effect of soil tillage and long-term nitrogen fertilization on corn yield

Treatment		Corn Yield (kg ha^{-1})
Tillage System	N (kg ha^{-1})	
No-Till	0	4,539
Minimum	0	4,495
Intensive	0	3,825
No-Till	200	7,058
Minimum	200	7,510
Intensive	200	6,104
Source of Differrent		F –calc.
N		34.44**
T		2.05^{nt}
NxT		0.24^{nt}

nt : Not Significantly Different at 5% ; ** : Significantly Different at 1%

In previous season, after plowing the long-term conservation tillage, nitrogen fertilization, N residue, and tillage system could increased the corn yield after 30-years croping (Yupitasari, 2018). As reported by Yupitasari (2018) in 31-years, minimum till and N fertilization 200 kg ha^{-1} still had highest corn yield.

CONCLUSION

SOC in particle size fraction was not effected by tillage and N fertilization. SOC in silt fraction was highest than other fractions. While corn yield in 200 kg N ha^{-1} had higher than without N fertilization.

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