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Chemistry and Management of Acid-Sulfate Soils

Key note

Short Oral

Poster Presentations

ROLE OF FRESH ORGANIC MATTER ON AGGREGATE STABILITY IMPROVEMENT OF ULTISOLS & CHILI (*Capsicum annum*) PRODUCTION UNDER WET TROPICAL RAINFOREST

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Abstract

This experiment was aimed to improve aggregate stability (AS) of Ultisol and chili (*Capsicum annum*) production by applying fresh organic matter (FOM) (*T.diversifolia, C.odorata,* and *G.sepium)* for three cropping seasons (CS-I, CS-II, CS-III). The result showed that Tithonia gave the highest SOM content and AS after CS-I and Chromolaena and Gliricidia after CS-II and CS-III but the highest production was under Gliricidia plot. The FOM effect decreased after CS-II and CS-III. It was concluded that the FOM did not have to be applied every CS for SOM and AS improvement but it had to do for chili production.

Keywords: Fresh organic matter, soil aggregate stability, wet tropical area, Ultisols

Introduction

Aggregate stability of soils in wet tropical region seems to be a key factor to minimize soil degradation, especially in the sloping areas such as in West Sumatra. High annual rainfall combined with wavy and hilly topography in the region has caused the soils become very susceptable to degradation mainly through erosion process. This is primarily found under annual cropping systems, in which farmers, for preparing seed bed, tend to cultivate the soils intensively causing SOM oxidized. Decreasing SOM content after cultivation was reported by many soil scientists (Yulnafatmawita *et al*, 2003; 2006; etc). Soil OM is considered as the best soil binding agent and soil aggregate stabilization (Tisdale and Oades, 1982).

Ultisol is one of acid soil being widely distributed in Indonesia. In West Sumatra, Ultisol has clay texture (accumulated on B2t horizon) and low SOM content (Yulnafatmawita, 2006) besides its poor soil chemical properties (Hakim et al, 2007). As reported by Yulnafatmawita *et al.* (2006) the OM content of Ultisol Limau Manis ranged from 1% to 3 %. The amount will decline fast as the soil is cultivated. Therefore, OM should be added to this soil regularly to improve soil aggregate stability and to avoid erosion and soil degradation.

Application of FOM being produced *in situ* would give double profits. It is not only able to degrade fast and then contribute to SOM content, but it is also able to reduce production cost. This is due to the fact that farmers do not need to pay for collecting and transporting the OM from the origin to the field site. This second earning is seemed to be very important for farmers in developing countries, especially in Indonesia since they do not have enough capital for farming. This research was aimed to determine the best type of FOM to inprove SOM, AS, and crop production in Ultisol under wet tropical rainforest region, and how long it could contribute to both soil properties and crop production.

Material and Methods

A field experiment was conducted at Ultisols (orthoxic tropudult) in Limau Manis (Imbang, et al., 1994) from 2008 until [illegible]. The area is located in lower footslope of Mount Gadut, Padang, West Sumatra Indonesia having wavy and hilly topography and receiving quite high annual rainfall, up to 6500 mm (Rasyidin, 1994). Three types of FOM applied were *Tithonia diversifolia, Chromolaena odorata*, and *Gliricidia sepium* growing well in the area. The FOMs were cut, and evenly distributed on soil surface (25% slope) before cultivating the soil for 20 cm depth. Amount of FOM applied was 1% (8 kg/4 m^2 plot) based on dry matter weight. The FOMs were kept for a month in the soil prior to crop seedlings were transplanted. There was a plot without applying FOM as a control. All plots were kept moist to assure FOM degradation. The plots were planted for three times (CS-I, CS-II, CS-III). Commercial fertilizers (Urea, KCl, and TSP) were added to all plots for crop growth at each cropping season. Soil physical properties were analysed before {(texture, SOM, ASI, %-Aggregation, hydraulic conductivity (HC), bulk density (BD), plant available water (PAW), total pore)} and after (SOM and ASI) experiment. Parameters for crop production were biomass and yield.

Results and Discussion

Initial Physical Properties of Ultisol Limau Manis

Some physical properties of Ultisol Limau Manis are presented in Tabel 1. It is showed that the soil had clay texture with [illegible] particles <2 um. High clay particles (>78%) also reported by Tan (2008). It is indicated that the soil has been advancedly weathered, since it is located under wet tropical rainforest (high annual rainfall and mean annual temperature). Soil OM content was classified into very low. Low SOM content combined with high clay content has caused the binding agent of the soil aggregates was dominated by clay. Aggregates bound by clay are less stable and easy to degrade, especially when the soil is cultivated or promply wetting. High clay content and low SOM also led the soil to have low HC, medium soil BD, total pore, and PAW.

Tabel 1 : Initial physical properties of Ultisol Limau Manis

Parameter	Soil Texture	Sand (%)	Silt (%)	Clay (%)	HC (cm/h)	BD (g/cm³)	TP (%)	PAW (%)	SOM (%)	Aggr (%)	ASI
Value	Clay	20.21	12.18	67.61	0.37	1.03	60.76	11.32	1.23	40.08	46.75

Note: HC=hydraulic conductivity, BD=bulk density, TP=total pore, PAW=plant available water, Aggr.=aggregation, ASI=aggregate stability index

SOM Content and Aggregate Stability Index

Soil properties and crop production after CS-I, CS-II, and CS-III are presented in Figure 1. In general, application of FOM to soil significantly increased SOM content and AS after CS-I. The effect decreased after CS-II, and CS-III, but it was still higher than that in control plot. At CS-I, tithonia gave the highest SOM and ASI (170% and 88% compared to the control plot, respectively). This could be understood that tithonia having high N, 3.5% combined with herbaceus stem and soft tissues (Hakim et al., 2007), caused it was degraded faster.

For CS-II and CS-III, the highest SOM content was found under Chromolaena plot and ASI under Gliricidia plot. This could be due to both Chromolaena and Gliricidia having stronger plant tissues than Tithonia, so they did not show much contribution on the CS-I as Tithonia did. Gliricidia has 12.54% lignin (Putra, 2006) that it is hard to degrade, but the decomposition result contributed to aggregation process and stabilization. Chromolaena has less N content (3.04%) than tithonia and lignin content (9%) than Glricidia (Pratikno, 2002). Figure 1-E showed a weak correlation (R^2=0.544) between SOM content and ASI of Ultisol Limau Manis after application of some types FOM. This could be due to some factors, such as its high clay content as well as its different types of OM source applied.

Crop Biomass and Yield

In general, crop biomass and yield increased by FOM application to Ultisol. The values were highest under Gliricidia plot for CS-I. Crop biomass and yield from Gliricidia plots increased by > 5 times (525 and 567%, respectively) compared to the control plot. At CS-II and CS-III, crop biomass and yield sharply decreased for all plots. Compared to SOM and AS of the Ultisol, the decrease in biomass and yield was much bigger than that in SOM content and ASI. At the CS-II and CS-III, the biomass declined by 90.4 and 90% and yield by 88% for both CS compared to the CS-I under Gliricidia plot. On the other hand, SOM only declined by 7.5% (at CS-II) and 4.3 (at CS-III), and AS tended to increase slightly. For control plot, the production also declined by time, the value decreased by 57.5 and 82.5% for biomass, and by 40 and 83.3% for yield, consecutively at CS-II and CS-III.

Conclusion

1. FOM could improve SOM content and ASI of Ultisol as well as chili production. 2.*G.sepium* application is better in terms of AS improvement for three CS and chili production for one CS.

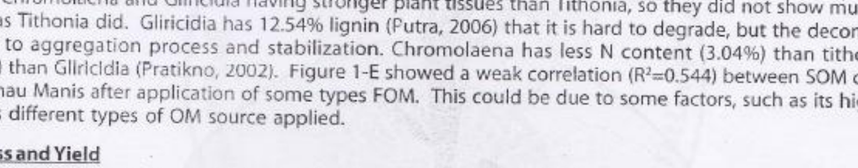

Figure 1. Effect of FOM application on SOM content (A), ASI (B) of Ultisol, chili biomass (C) and yield (D) as well as relationship between SOM and AS for three cropping seasons (=CS-I; =CS-II; =CS-III)

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