ISBN : 978-4-909365-04-0

PROCEEDINGS of IC-GU 12 UGSAS-GU

"6TH INTERNATIONAL WORKSHOP ON CROP PRODUCTION AND PRODUCTIVITY UNDER GLOBAL CLIMATE CHANGE"

Editors :

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DECEMBER 3-4, 2018

at FACULTY OF AGRICULTURE, LAMPUNG UNIVERSITY
BANDAR LAMPUNG, INDONESIA

Aggregate Stability and Root Biomass Affected by Soil Tillage and Mulching in Green Nut Cultivation (*Vigna radiata* L.)

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Abstract

The bare intensife tillage applied on agricultural land can drastically reduce soil quality. One of the efforts to prevent it is by applying mulch and conservation tillage. The objective of this study was to determine the effect of minimum tillage and mulch on soil aggregate stability and root biomass. This study was designed in the field using a randomized block design (RBD) with 2 factors and 4 repetitions. The first factor was tillage (minimum tillage (T1) and intensife tillage (T2)). The second factor was mullch (without mulch (M1) and 5 Mg mulch ha^{-1} (M2)). The aggregate stability was determinate using water-drop method (WDM). The results showed that the minimum tillage affected the increasing soil aggregate stability of the 6 mm and 3 mm diameter aggregate before land preparation and after harvesting, except, the 3 mm diameter aggregate before land preparation. The minimum tillage also increased root biomass during the vegetative period of the plant. The treatment of 5 Mg mulch ha^{-1} affected in increasing the soil aggregate stability of 3 mm diameter aggregate after harvest but not the soil of 6 mm diameter aggregate. No interaction was found between the minimum tillage and 5 Mg mulch ha^{-1} on soil aggregate stability and root biomass.

Introduction

Land preparation was an important thing for any crop cultivation. Intensive tillage can damage soil structure but also stimulates soil oxidation in which the decomposition of organic matter much faster. The decrease of aggregate stability is very common in crop farming systems (Rachman and Abdurachman, 2006) since soil in intensive tillage when rain can break up the soil aggregate (Refliaty and Marpaung, 2010). Sarief (1989) reported that excretion and root penetration can stimulate or be affected by soil structure. The more roots found in the soil, the higher the root biomass results in the more stable soil structure will be. The objective of this research is to study the effect of minimum tillage and mulch on soil aggregate stability and root biomass.

Material and Method

The location of the research was carried out at the Integrated Field Laboratory, Lampung University. This study in the field was designed using a randomized block design (RBD) with 2 factors and 4 replications. The first factor was tillage (minimum tillage (T1) and intensife tillage (T2)). The second factor was mullch (without mulch (M1) and 5 Mg mulch ha^{-1} (M2)) The aggregate stability was determinate using water-drop method (WDM) (McCalla, 1944). The average results of the observed values of the data were tested by the BNT test level of 5%.

Result and Discussions

Effect on Soil Aggregate Stability

Table 1 showed that soil aggregate stability before land preparation was significantly higher for 6 mm diameter compare to that of intensive tillage and with no mulch, but not significantly in mm diameter .The tillage system treatment significantly reduced the stability of 6 mm and 3 mm soil aggregates after harvest. Mulching treatment was not significantly different from aggregate stability at all size and time of observation except for soil 3 mm diameter aggregates which showed significantly different observations after harvest. .

Effect on Roots Biomass

Root biomass in the minimum tillage was very significantly different compared to intensive tillage during vegetative period of the plants (Table 2). This is because the condition of minimum tillage is more able to provide space for roots to grow and develop. A good root growth process will increase root biomass. In addition, it is suspected that the breakdown of roots in the soil due to intensive tillage treatment so that the roots decompose faster, while in the minimum tillage which is only treated as needed does not damage the root growth rate. Prasetyo, et al., (2014) stated that maximum tillage was an act of reversing, cutting, destroying and leveling the soil by removing plant debris that interferes with growth, while minimum tillage is a sufficient soil cultivation by maintaining

crop residues the former is still on the surface of the land.

Table 1. Aggregate stability of 6 mm and 3 mm diameter soil aggregates

Soil aggregate	Treatment	Soil aggegate stability (kinetic energy = J)	
		BL	AH
6 mm	T1	5,96 b	3,99 b
	T2	4,06 a	2,81 a
	F Test	*	*
	HSD 0,05	1,81	0,98
	M1	4,84	3,00
	M2	5,18	3,81
3 mm	T1	1,75	1,78 b
	T2	2,16	1,22 a
	F Test	ns	**
	HSD 0,01	-	0,41
	M1	1,92	1,35 a
	M2	1,99	1,65 b
	F Test	ns	*
	HSD 0,05	-	0,29

Table 2. Effect of the tillage system and mulch on root biomass in the green nut plants

Treatment	Root biomass (kg m^{-3})		
	BL	VP	AH
T1	0,69	3,22 b	0,48
T2	0,54	1,39 a	0,27
F Test	ns	**	ns
HSD 0,05	-	0,67	-
M1	0,61	1,98	0,40
M2	0,61	1,66	0,35
F Test	ns	ns	ns

Effect on C- organic

The content of total -C (%) in the tillage treatment and with mulch were not significantly different in all phases of observation . It is presumed that the source of organic matter given through mulch or from plant tissue that falls to the soil on the land had not been completely decomposed during the study period..

Correlation Aggregate Stability with Root Biomass

The correlation test results between aggregate stability and root biomass showed no significant correlation of the soil neither on 3 mm diameter of the aggregate nor on 6 mm

Correlation Aggregate Stability with Total-C of Soil

The correlation between soil aggregate stability and the total-C of 3 mm diameter was not significantly correlate but it was significantly correlate on the 6 mm diameter soil aggregate (Table 3). It was suspected that root exudates in the form of sugars and organic compounds that fill a large aggregate pore would be fragmented into smaller aggregates when the compound decomposes. Ladd, et al. (1996) reported that organic compounds such as organic acids and polysaccharides were able to bind soil particles into smaller, more stable aggregates of soil. Organic matter (polysaccharides) decomposes faster by microorganisms is a temporary aggregate binding agent (Tisdall and Oades, 1982).

Table 3. The correlation soil aggregates 6 mm and 3 mm diameter to C- organic (%)

Variable	Correlation coefficient	
	Soil aggegate stability (kinetic energy = J)	
	6 mm	3 mm
C-organic	- 0,444 *	0,149 ns

ns = no significant effect, * = significant effect.

Conclusion

1)The minimum tillage improved the aggregate stability of the 3 mm and 6 mm diameter aggregate on the soil before land preparation and after harvest, but not in the soil of 3 mm diameter aggregate on before land preparation. The minimum tillage increase root biomass in the vegetative period of the plant, but not in before land preparation and after harvest.

2) Treatment of mulch 5 Mg ha^{-1} increased the stability of aggregate of 3 mm diameter of soil aggregate after harvest, but not for soil 3 mm diameter aggregate before land preparation. The mulch 5 Mg ha^{-1} did not increase root biomass.

3) No interaction was found between the minimum tillage and 5 Mg mulch ha^{-1} on soil aggregate stability and root biomass.

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