ARTICLE BOOK

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The soil aggregate stability influenced by hazelnut husk compost application: main effects of soil texture and sampling period

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Introduction

Today, environmentally friendly agricultural activities draw attention. Organic wastes are healthy inputs for agricultural soils. Organic matter affects soil chemical, physical and biological properties and its overall health. Soil properties influenced by organic matter includes such as; soil structure and aggregation, soil erodibility, moisture holding capacity, diversity and activity of soil organisms, both those that are beneficial and harmful to crop production, and nutrient availability. Also soil organic matter determines the related to soil sustainability and soil erodibility. A soil aggregate is “a group of primary soil particles that cohere to each other more strongly than to other surrounding particles.” Soil aggregates form through the combined action of aggregation and fragmentation processes. Important physical aspects of aggregates include their size, density, stability, structure, and their effect on the transport of fluids, solutes, colloids, and heat (Nimmo, 2004). Aggregate stability determinations are to give a reliable description and ranking of the behavior of soils under the effect of water, wind and management in soils. Soil organic matter status and soil aggregate stability are the key factor for assessing of soil quality related to soil quality monitoring. The temporal variability of the soil aggregate stability was shown for instance by Chan et al. (1994), and Yang and Wander (1998). Yang and Wander (1998) suggested that the higher aggregate stability was found due to crop roots, exudates microbial by-products and wet/dry cycles. The farmers prefer environmentally friendly agriculture activities by emphasizing on the environmental and human and animal health, had to use some alternative products with organic origins that could replace agricultural inputs such as chemical fertilizers and pesticides; and had to increase the effectiveness of the products used. For this purpose, they firstly had to use compost products, which have been used for centuries to increase the level of soil organic matter (SOM). Approximately 600–650 thousand tons of hazelnuts are produced annually on 621000 ha in Turkey. At the end of the hazelnut harvest, nearly the same amount of HH residues remain as agricultural waste. Dried hazelnut husk has 93.16% organic matter content. Moreover, hazelnut husks are suitable for agricultural use in terms of their pH and salinity. In terms of nutritional elements, while nitrogen and phosphorus were inadequate as limit values, potassium and micro-elements were adequate. Husk is difficult to decompose as it has a high C/N ratio (>50/1). After mixing hazelnut husk into soil, it can take about 2 or
2.5 years for microbial processes to decompose it. Therefore, HH must be applied soil after composting to increase SOM level and nutrient availability in soil.

In this study, in order to determine the changes in the soil aggregate stability when the HHC, which is obtained through composting HH by using molecular biotechnological methods (Kızılkaya et al. 2015a,b), is applied on the hazelnut orchard soils with different textures such as; CL and CL and at increasing levels (0, 1.25, 2.5, 5.0, 7.5 and 10 ton da⁻¹). Then, WAS was investigated in different sampling time such as; spring, summer, fall and winter.

Materials and Methods

HH (C/N ratio 55.71; pH 5.81; EC_{25°C} 1.93 dS m⁻¹; 0.97% N) was collected from the hazelnut orchard as a waste material, was inoculated with this HH, C and the microorganisms used as an energy source (Kızılkaya et al., 2005a,b), was composted by windrow method and was used as a material in experiments using a windrow machine in the Research Facility of Soil Science and Plant Nutrition Department in Ondokuz Mayıs University, Samsun, Turkey. HHC properties are as follows: pH is 6.76, EC_{25°C} is 3.56 dS m⁻¹, organic matter (OM) content is 94.75%, total N content is 2.48%, and C/N ratio is 22.16. Field experiments were conducted in two different hazelnut orchard with different textures (sandy loam - sand% 76.14, silt% 9.62, clay% 14.24, pH 6.23, EC_{25°C} 0.04 dS m⁻¹, SOM 1.41% - clayey loam - sand% 33.55, silt% 27.86, clay% 38.53, pH 6.69, EC_{25°C} 1.43 dS m⁻¹, SOM 2.58%) soil located in Ordu at the Black Sea Region of Turkey. Experiments conducted in hazelnut orchards with SL and CL textured soils in November 2012, were based on with randomized complete block design. HHC was incorporated into the top 20 cm of the soil around the plant canopy without mixing any other material using a hoe in six application doses with three replication. Total experiment consisted of 36 parcels in order to increase the content of SOM by 0, 0.5% (1.25 ton da⁻¹), 1% (2.5 ton da⁻¹), 2% (5 ton da⁻¹), 3% (7.5 ton da⁻¹) and 4% (10 ton da⁻¹). Soil samplings were done at the end of the March, June, September and December 2013 to determine soil aggregate stability. In statistical analysis, MINITAB Statistic 17.0 program was used.

Results and Discussion

Soil aggregate stability did not significantly affected by the HHC treatments in hazelnut orchards. Although the aggregate stability was not affected by the dose increasing of HHC, was effected by soil texture, sampling time and their interactions (Table 1 and Fig. 1).

It was found out that due to the increases in the dose of HHC applied on soils with different textures, the soil aggregate stability increased. HHC treatments showed no significant relationships with the soil aggregate stability according to the control. The highest aggregate stability was measured in clay loam textured soil. The change HHC application caused on the soil aggregate stability was found to be more distinct in clay loam soil (Table 1, Fig. 1).

The highest aggregate stability was measured at the end of June while the lowest was at the end of September which is the nearly same with winter sampling time (31 December 2013 in sampling time). There were significant differences on aggregate stability (as mean values). Our results were the compatible with the other researcher’s
findings. Veronica et al., informed that soil aggregate stability depends on stage of the root zone development, soil management and climatic conditions. The highest aggregate stability was measured at the end of April in the years 2007 and 2008 in Haplic Luvisol and Greyic Phaeozem, and at the end of June in the year 2007 and at the beginning of June in 2008 in Haplic Cambisol (Veronica et al., 2010). Dimoyiannis (2009) reported under typical Mediterranean climatic conditions, WAS of air-dried aggregates appreciably varies seasonally according to a nearly cyclic pattern, being in general lowest in winter and highest in summer. Eventually, it was concluded that the most convenient level of HHC to be added into the soils is 5 ton da⁻¹, considering the aggregate stability in the soils and consequently the management principles of the organic substances added into the soils.

Table 1. ANOVA for soil aggregate stability values (n=144).

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Seq SS</th>
<th>Adj SS</th>
<th>Adj MS</th>
<th>F-Value</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soils</td>
<td>1</td>
<td>5215.2</td>
<td>5215.2</td>
<td>5215.25</td>
<td>198.53</td>
<td>0.000</td>
</tr>
<tr>
<td>HHC Doses</td>
<td>5</td>
<td>142.1</td>
<td>142.1</td>
<td>28.43</td>
<td>1.08</td>
<td>0.375</td>
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<tr>
<td>Sampling time</td>
<td>3</td>
<td>11819.9</td>
<td>11819.9</td>
<td>3939.97</td>
<td>149.98</td>
<td>0.000</td>
</tr>
<tr>
<td>Soils x HHC Doses</td>
<td>5</td>
<td>358.7</td>
<td>358.7</td>
<td>71.73</td>
<td>2.73</td>
<td>0.024</td>
</tr>
<tr>
<td>Soils x Sampling Time</td>
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<td>2156.7</td>
<td>2156.7</td>
<td>718.92</td>
<td>27.37</td>
<td>0.000</td>
</tr>
<tr>
<td>HHC Doses x Sampling time</td>
<td>15</td>
<td>1262.7</td>
<td>1262.7</td>
<td>84.18</td>
<td>3.20</td>
<td>0.000</td>
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<tr>
<td>Soils x HHC Doses x Sampling Time</td>
<td>15</td>
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<td>715.7</td>
<td>47.72</td>
<td>1.82</td>
<td>0.043</td>
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<tr>
<td>Error</td>
<td>96</td>
<td>2521.9</td>
<td>2521.9</td>
<td>26.27</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>143</td>
<td>24193.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig. 1. Effects of soil texture, HHC application and sampling time on the WAS. (***: non significant; *: p<0.05; **: p<0.01; ***: p<0.00; Means that do not share a letter are significantly different at p<0.05).
Fig. 2. Main effects plot of soil texture, HHC doses and sampling time on the WAS. (Means that do not share a letter are significantly different at p<0.05).

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References