Effects of the applied organic matter on soil gaseous-transport properties: case at the 1st year after the application

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1. Introduction

Soil compaction is mainly caused by farm machinery operations, and the compaction in turn may alter soil aeration by decreasing the soil porosity. Organic matter, on the other hand, is well known enable to decrease the effects of compaction and improve the other soil physical properties. However, effect of the applied organic matter on soil gaseous-transport properties is yet rarely documented. Thus, this study was aimed to investigate the effects of the applied organic matter on soil relative gas diffusivity D_p/D_0 and air permeability k_a [μm^2].

2. Materials and method

Each of rice husk, rice stem, compost, sawdust, and wood bark was applied into a 80 cm x 100 cm sub-plot (clayey loam soil) at rates of 10%, 20%, and 30%, respectively (soil volume basis by taking 15 cm in soil depth). Disturbed soil samples were then taken at a week, 6 months, and a year after the organic matter application.

At a certain water content (referred to the control soil), the samples were repacked into a 471 cm^3 cylinder (10 cm i.d. and 6 cm length) and compacted under static load of 300 kPa using a modified triaxial test machine. Afterward, the specimen were saturated, and then be drained at -100 cm H_2O soil matric suction (hanging water column method) for D_p/D_0 and k_a measurements.

D_p/D_0 and k_a were measured using a method as described by Kuncoro and Koga (2012), upon which plastic films' shutter was used for the D_p/D_0 measurement and Mariotte's bottle with manometers was used for the k_a measurement. The D_p/D_0 measurement was based on the solution given by Currie (1960) as described by Rolston and Moldrup (2002). While, k_a was calculated from the volume flux of the permeated air, which was determined from the air volume change inside the Mariotte's bottle after the atmospheric air has been pulled-in into the system for a certain constant head.

3. Results and discussion

The applied organic matters tended to result in higher D_p/D_0 and k_a as shown in Fig. 1 and Fig. 4, respectively, even though there was poor linearity between the increase in D_p/D_0 and k_a and the rate of the applied organic matters. As the time elapsed, however, the increase was getting less, and the organic matters tended to act in different manners individually.

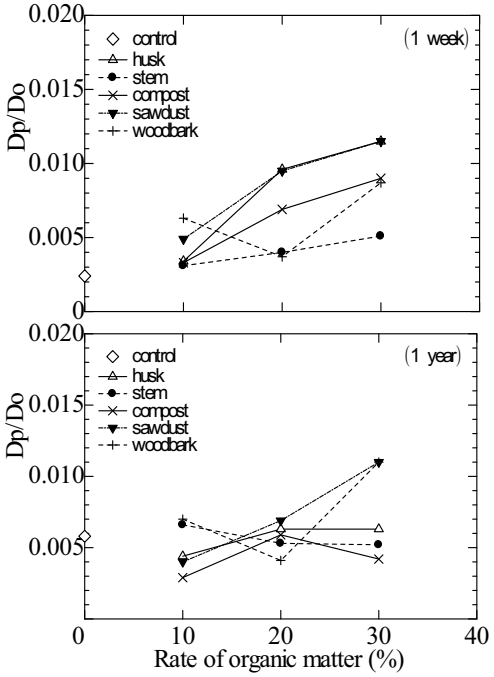

Fig. 1 Measured D_p/D_0

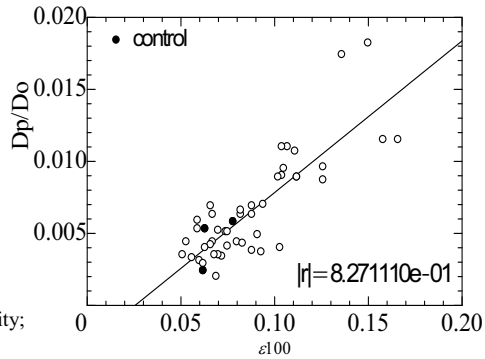

Fig. 2 ε_{100} vs. D_p/D_0

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The increase in D_p/D_0 might be due to the increase in soil air content ε (Fig. 2) and the less tortuosity in soil pores network as indicated by the higher specific gas diffusivity ($[D_p/D_0]/\varepsilon_{100}$) (Fig. 3) after the organic matter applications. After a year, sawdust seemed to be most effective, while stem remained least effective compared to the other organic matters.

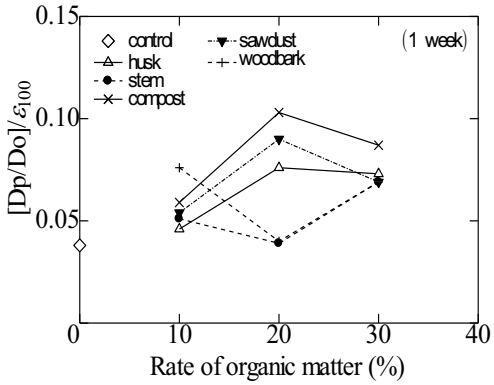

Fig. 3 Specific gas diffusivity

While, the increase in k_a was considered to be reasonably attributed to the increase in the number of soil macropores as indicated by the higher soil air content at -100 cm H_2O soil matric suction (ε_{100}) after the organic matter applications. In addition, the increase in k_a might be also due to the increase in the continuity of soil macropores as indicated by the higher specific air permeability (k_a /ε_{100}) (Fig. 5) after the organic matter applications. Husk seemed to be most effective, while stem remained least effective compared to the other organic matters particularly at a week measurements.

4. Conclusion

The applied organic matters tended to increase D_p/D_0 and k_a , even though there was poor linearity between the increase and the rate of the organic matter. As the time elapsed, the increase was getting less, and the organic matters tended to act in different manners individually. The increase in D_p/D_0 was reasonably due to the increase in soil air content and the less tortuosity in soil pores network after the organic matter applications. While, the increase in k_a might be reasonably attributed to the increase in volume and continuity of the soil macropores after the organic matter applications.

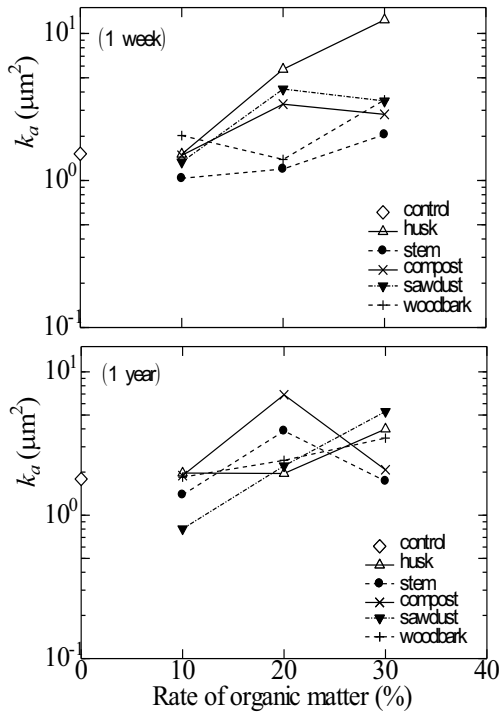

Fig. 4 Measured k_a

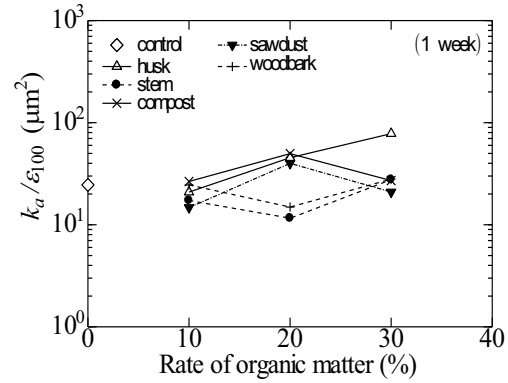

Fig. 5 Specific air permeability

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