締固めが土のガス輸送特性に与える影響
The effects of compaction on soil gaseous-transport properties

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1. Introduction

Soil compaction in agricultural field is mainly caused by farm machinery operations, and the compaction in turn may alter soil aeration by decreasing soil porosity. Organic matter (OM), on the other hand, is well known to enable to decrease the effects of compaction and improve other soil physical properties. However, effect of compaction on gaseous-transport properties of the OM-applied soil has not yet been fully documented. Thus, this study was aimed to investigate effects of compaction on relative gas diffusivity D_p/D_0 and air permeability k_a [μm^2] of the OM-applied soil.

2. Materials and method

Each of rice husk, rice straw, compost, sawdust, and wood bark was mixed with the sample of sandy loam soil at 20% volume, just prior to the compaction. The compaction was conducted at 70% water content (referred to control) for 150, 225, and 300 kPa using a modified triaxial test machine (static load). Afterward, the specimen was saturated with water, and then was drained at -100 cm H_2O soil matric suction (hanging water column method) for D_p/D_0 and k_a measurements.

The measurement of D_p/D_0 and k_a were performed in triplicate using a method from Kuncoro and Koga (2012). Calculation for D_p/D_0 was based on the solution given by Currie (1960), while k_a was calculated based on the Darcy's law.

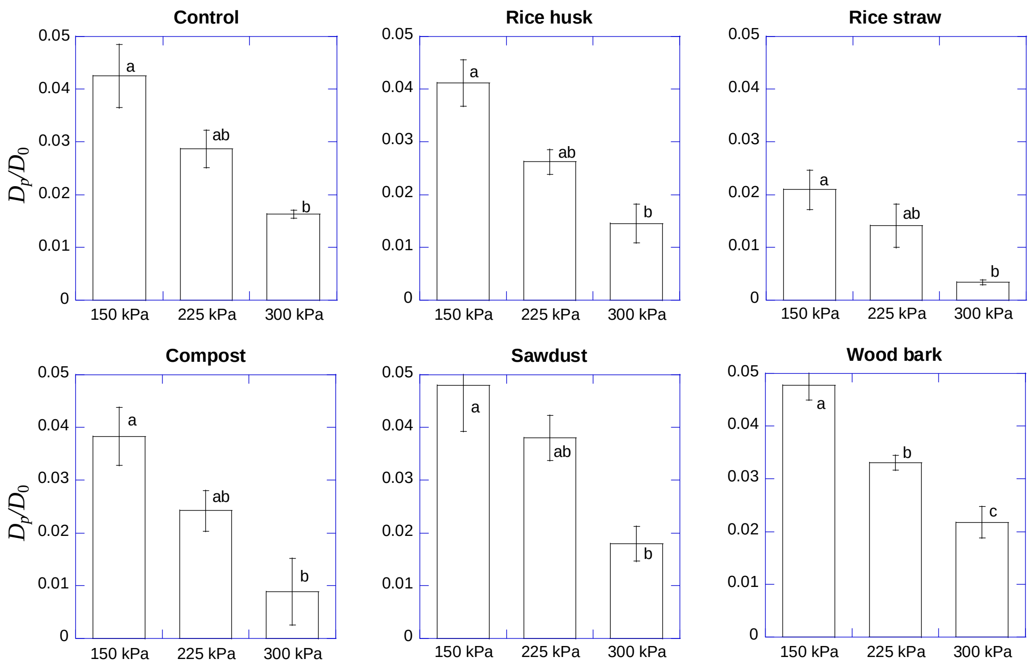

Fig. 1 Mean of measured D_p/D_0 for different level of compactions
(same letter are not significantly different for Anova - Tukey HSD test P<0.05)

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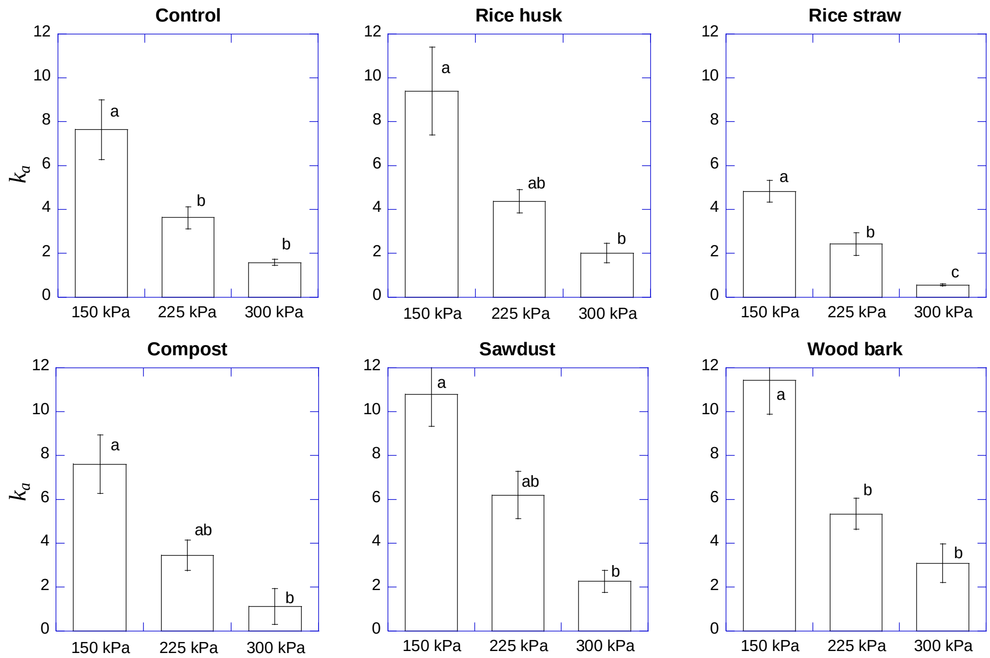

Fig. 2 Mean of measured k_a for different level of compactions

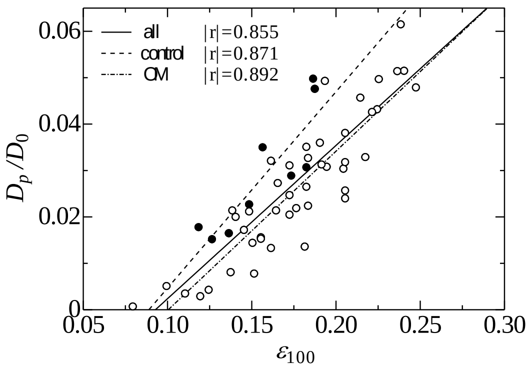

Fig. 3 D_p/D_0 vs. ε_{100}

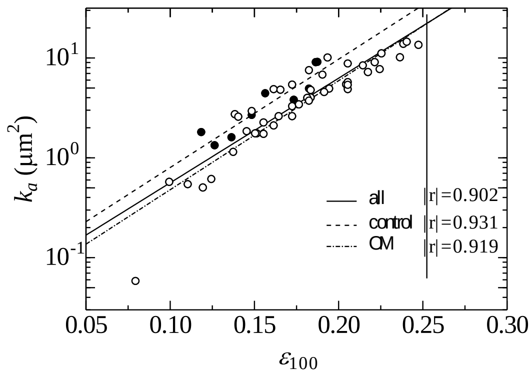

Fig. 4 k_a vs. ε_{100}

3. Results and discussion

Figs. 1 and 2 show that D_p/D_0 and k_a decreased with compaction levels, respectively, and the difference was significant between 300 kPa and 150 kPa. There was a tendency that incorporation of wood bark and sawdust increased D_p/D_0 and k_a, whereas rice straw and compost gave reverse effects.

Likewise, air content at -100 cm H_2O soil matric suction (ε_{100}), which also represents equivalent volume of soil macropore ($\phi \geq 30$ μm), decreased with compaction (data were not shown). On the other hand, Figs.3 and 4 show high positive linearity between D_p/D_0 and ε_{100}, and between k_a and ε_{100}, respectively. Thus, the decrease in D_p/D_0 and k_a with compaction in this study were considered to be attributed to the decrease in the air volume of soil macropore.

Further, for the same ε_{100}, control soil tended to result higher D_p/D_0 and k_a than the OM-applied soil. This result may suggest an existence of such blockage effect from the applied OM on the soil gaseous-transport processes (pores became more tortuous).

4. Conclusion

Soil gas diffusivity (D_p/D_0) and air permeability (k_a) decreased with compaction level. The decrease in D_p/D_0 and k_a was attributed to the decrease in the air volume of soil macropore, of which the effect was more distinct for k_a.

References

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