A study on the soil bulk density as affected by compression in column test

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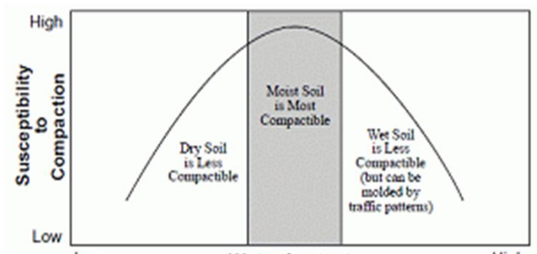
INTRODUCTION

❖ Research Background

- Soil compaction is mainly occurred by a heavy agricultural machinery, which leads to change the soil porosity distribution.
- The soil porosity distribution that influences the water holding capacity and the aeration work as a limiting factor for the crop growth.
- A quantitative assessment of soil compaction is required to enhance soil management for crop production and environmental sustainability.

※ The relationship of soil compaction and crop growth (UK, 1990)



Crop growth	Penetration resistance (MPa)
Low	<1.0
Medium	1.0-1.5
Severe	2.0-3.0

❖ Research Purpose

- To investigate the relationship of the pressure on soil and the bulk density
- To analyze the relationship of aeration porosity and bulk density in the laboratory prior to practicing field experiment.

MATERIALS AND METHODS

◆ Analysis of soil penetration resistance for upland according to soil moisture condition

*object soil : coarse and fine soil

◆ Experiment 2 Analysis of porosity characteristics by bulk density ; undisturbed

- Aeration porosity (%)

Gaseous phase ratio at 10kPa

=Total porosity-Soil moisture content at 10kPa

- Soil : Sandy loam, Silty clay loam

◆ Experiment 1. Assess of soil compaction effect on pressure by using apparatus designed for compaction; disturbed

- Soil texture : Sandy loam, Silty clay loam
- Soil moisture content levels for SL (%, w/w) : 4.2, 16.0, 20.3
- Soil moisture content levels for SiCL (%, w/w) : 11.6, 15.0, 19.5, 25.0
- Applied pressure (MPa) : 0.17~2.68
- Measurement : Bulk density (Mg m^{-3})

< Soil compaction equipment, designed by K. Y. Jung>

RESULTS

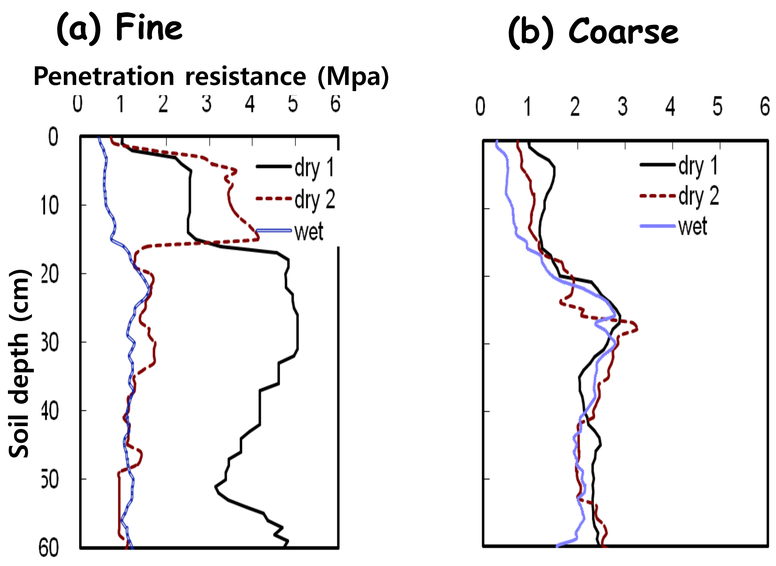


Fig. 1. Penetration resistance according to the soil moisture condition and soil texture

Table 1. Particle size distribution of conducted soil.

Soil Type	Sand						Silt	Clay	Texture
	VC	C	M	F	VF	Total			
	%								
Fine	2.2	4.0	2.8	1.8	1.8	12.6	56.0	31.5	SiCL
Coarse	3.6	12.8	25.6	20.0	8.3	70.3	23.7	6.0	SL

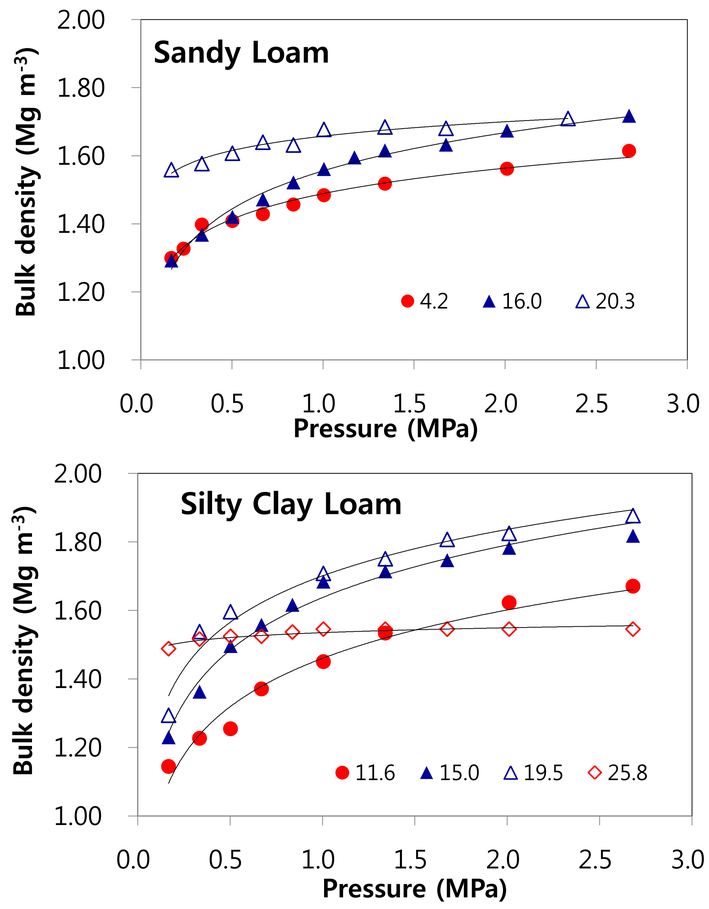


Fig. 2. Relationship of pressure and bulk density for silty clay loam and sandy loam according to soil water contents ($p<0.01$).

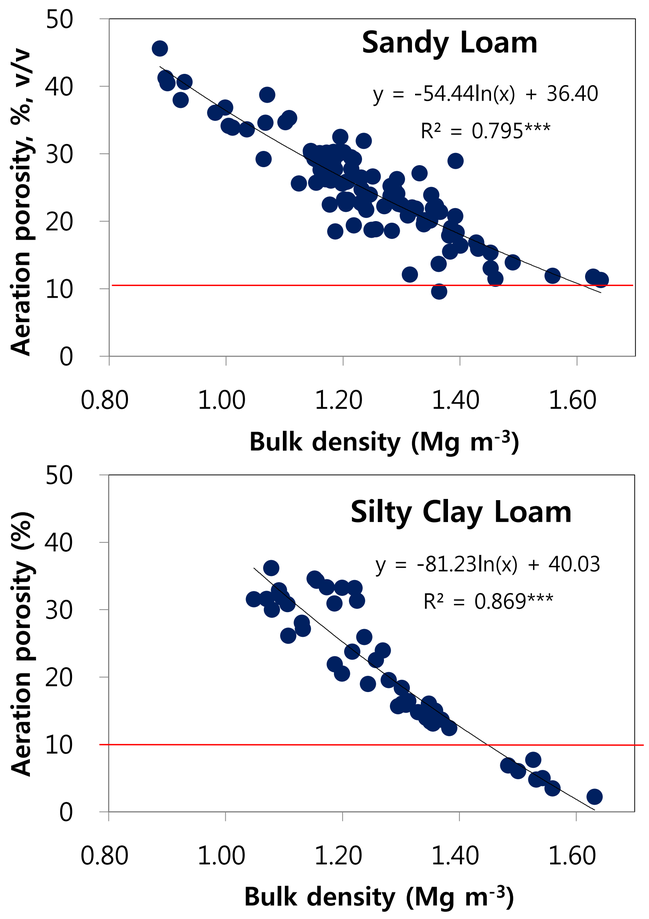


Fig. 3. Relationship of bulk density and aeration porosity for silty clay loam and sandy loam ($p<0.01$).

CONCLUSION

- The penetration resistance is variable with soil water contents in fine textural soil, especially in plow pan, about 15~20 cm, which is higher under dry condition.
- The increment of bulk density increased with increasing pressure, which gradient is higher in clay loam than in sandy loam. That characteristics increase with increasing soil water content within some water content, which point is different with soil texture, showing in sandy loam, at 20.3%, in silty clay loam, 25.8%.
- As the bulk density increases, the aeration porosity decreases, which slope is steeper on silty clay loam than sandy loam. To maintain aeration porosity at least 10%, bulk density is required to less than 1.62 Mg m^{-3}, 1.45 Mg m^{-3} in SL, SiCL, respectively.
- Therefore, it would be required to be careful for soil compaction in soil with higher clay content rather than in sandy loam as driving an agricultural machinery. Also, it is recommended to consider an invulnerable soil moisture condition related to soil texture.