Hydraulic properties of clay loam paddy soils in Japan.

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Introduction

Paddy rice is a typical agricultural practice in monsoon Asian countries such as Japan. Historically, paddy fields adopted to wet soil conditions such as low land and high precipitations. Since it was assumed paddy field is ponding during cropping season, unsaturated soil properties such as water retention and unsaturated hydraulic conductivity had not been a topic of science in paddy soils. However, recent agricultural practices i.e. direct seeding and winter sowing of rice may be affected by soil moisture condition of spring before surface water ponding.

Methods and Materials

We choose 11 experimental sites. Four of them are clay loam soil (CL) and rest of five soils were boundary of either clay loam-sandy clay loam (SCL) or clay loam-light clay (LiC). Rest of two soils were still CL but had distinctly more clayey. Soil moisture sensors were varied at a depth of 5 and 10 cm and soil temperature and moisture were monitored. Besides, undisturbed and disturbed soil samples were taken and texture, dry bulk and particle densities, and saturated hydraulic conductivity were measured. For soil water retention, sand box was employed for high matric potential range, 0 to -6 kPa. Evaporation method by Hyprop (Meter Environment, Inc.) was employed for middle range of matric potential such as higher than approximately -40 kPa. Also, water content at -101.3 kPa by pressure plate and at smaller than -200 kPa by psychrometer (WP4, Meter Environment, Inc.) were used as supplementary for low matric potential range. In addition to the measurement, water retention curve of each soil was predicted using soil texture and dry bulk density by Rosetta model (Schaap et al., 1998) and SolphyJ database combined with RETC (Kato and Nishimura, 2016).

Results and Discussion.

Water retention measured by sand box often showed smaller water contents. Still the reason is not clear however, in comparison with porosity it could be underestimation of water retention. Thus, we omitted the results of sand box for further discussion.

Even for the same texture water retention varied a lot. Within the one texture class, LiC and CL soils, water retention curves of soils in both texture class were very different. Natural factor such as soil type and mineralogy, and artificial effect such as tillage practice could affect the hydraulic property.

Distinctly low matric potential, i.e. smaller than -100 kPa, is important to discuss growth of plant. For this matric potential range, water retention predicted by Rosetta model agreed well with the measured water retention curves, even though there was large discrepancy in high matric potential range. SolphyJ combined with RETC could consider information of soil type more than Rosetta model, however, it could not evaluate water retention of the eleven experimental well. So only for assessing draught risk for spring germination, prediction of water retention from dry bulk density and soil texture may be usuful.

As mentioned above, soil texture of the nine experimental sites are very similar. However, small difference in texture could affect soil moisture conditions. According to the soil monitoring data, three experimental sites with soil texture of either SCL or SiCL were suffered from very low soil water matric potential during early spring. This could inhibit sprout of germinated seeds. This trend was rarely observed the other experimental sites with CL and LiC soils.

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