Relation of evaporation and transpiration to maintain plant production

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Abstract
Andisol in a pot was placed in a controlled air condition room and evaporation rate was measured. After that, another similar pot with leaf plants were placed in the same room but with light condition in daytime to measure evapo-transpiration rate. Analysis of the evaporation rate revealed that the rate was well expressed the simple function of time as ArcSinh[t]. Analysis of the evapo-transpiration showed an almost constant daily pattern during first several days but after that the rate decreased. This decrease was almost proportional to the decrease in soil water content.

Key Words
Evaporation rate, Evapo-transpiration rate, controlled air condition, water supply capability.

Introduction
To maintain optimal condition for plants to do photosynthesis, maintenance of soil moisture to an appropriate level is essential. At the same time, efficient water use also should be considered. So, we have to know the appropriate soil water content, first, to maintain plants under a good water condition, and secondly, not to lose water excessively through evaporation and deep percolation.
We used a leafy plants to identify if there was a critical water content under which the plant could not do sufficient transpiration and so could not photosynthesise. This information of the existence of a critical water content should be very useful for maintaining plant production while preventing excessive water use.

Methods
Measurement and analysis of the evaporation rate
Andisol filled a test pot of 25 cm in dia. and 50 cm deep. First this pot was saturated with water and drained to remove excess water, and then placed in an air conditioned room. Total weight, TDR and matric potential were measured every minute. Data were processed using equations for water dynamics.

Measurement and analysis of the evapo-transpiration rate
After finishing the previous test it was repeated but this time eggplant and a leafy plants were planted in a same pot and placed in the air conditioned room. Artificial lights were put on to simulate day time conditions. Total weight of the pot was measured every minute to obtain the evapo-transpiration rate.

Results
The measured weight was plotted in Figure 1 with dots, while fitted functional values are indicated with a line. Evaporation rate calculated from the fitted function is shown in Figure 2.

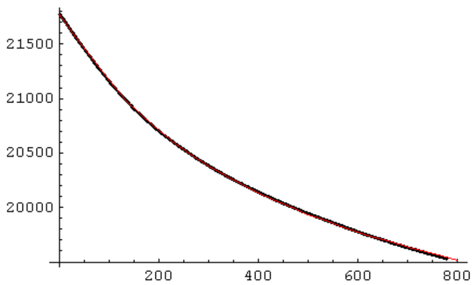

Figure 1. Measured weight of the soil pot. X: Time t in hour, Y: Weight in gram. Dots are measured and the line is fitted with Y=21775-919.644*ArcSinh[0.00722948*t]

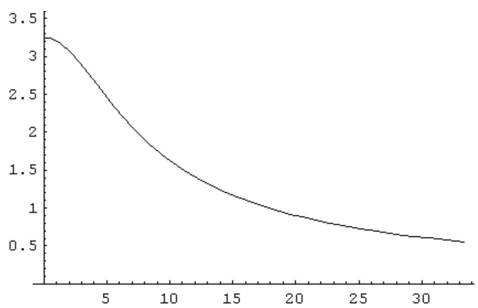

Figure 2. Evaporation rate calculated from Figure 1. X: Time t in day, Y: Evaporation rate in mm/day.

Transpiration rates were affected by soil water content, and the critical values were about 0.4 mL/mL as shown in Figures 3 and 4.

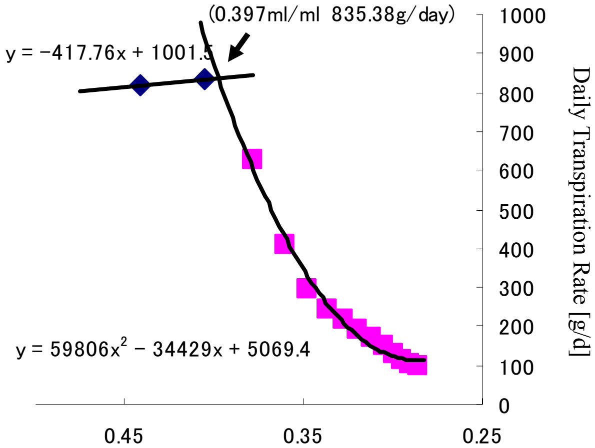

Figure 3. Daily transpiration rate was affected by volumetric soil water content (mL/mL), case No.1 for eggplant.

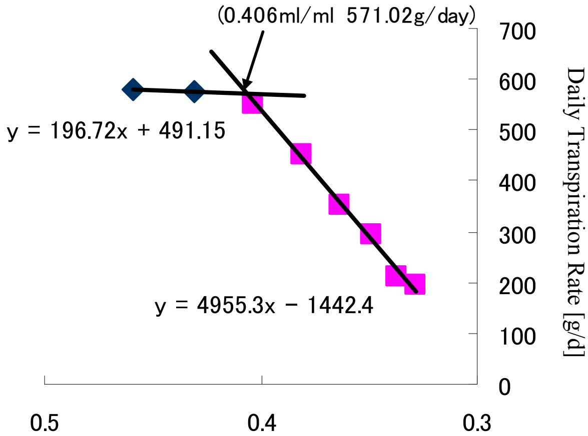

Figure 4. Daily transpiration rate affected by volumetric soil water content (mL/mL), case No.2 for the leafy plant.

Conclusion

Weight loss by evaporation is expressed as a simple equation using a mathematical function ArcSinh. Transpiration rate was critically affected by soil water content. The critical soil water contents were about 0.4 for our cases

References

Nabatame T (2008) Relationship between soil wetness and transpiration from plants. Master Thesis, Graduate School of Iwate University, 32+5pages.

Narita K (2008) Evaluation of water supply capability of *Akadamatsuchi*-soil(Andisol). Master Thesis, Graduate School of Iwate University, 56 +14pages.