Effective Use of Sub-Irrigation Water in Sandy Soil using Barrier of Gravel and Porous-Alpha Layers

Mitsuhiro Inoue*1, Bouya Ahmed Ould Ahmed*1 and Haruyuki Fujimaki*2

*1 Arid Land Research Center, Tottori Univ., *2 University Tsukuba, JAPAN E-mail: m11minoue@alrc.tottori-u.ac.jp

Introduction

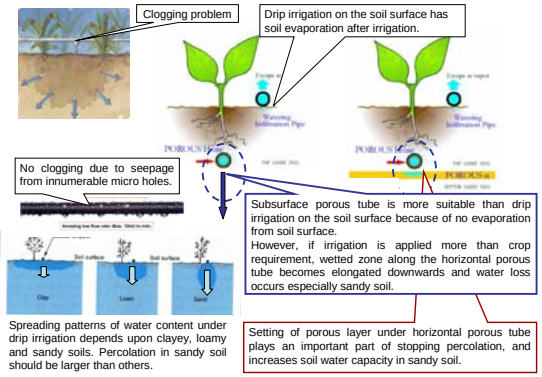
Limited availability of water for irrigation can restrict growth and production in many crop-irrigated areas, and particularly in arid regions. Water supplies that rely solely on precipitation are often limited and erratic. It is necessary furthermore for us to study the ultimate saving water system in sandy soil. Because sandy soil is widely distributed as developable agricultural field in arid regions. Drip or sub-surface irrigation system should be useful for sustainable agriculture.

Objective

The objective of this study was to investigate the effect of porous-alpha (recycled from used glass bottles) and gravel layer on water holding capacity and crop growth in sandy soil assessed by growing Japanese Green Mizuna, Swiss chard, and Tomato using rubber sub-surface porous tube (recycled from used tire).

Background

Construction of ultimate saving water system in sandy soil

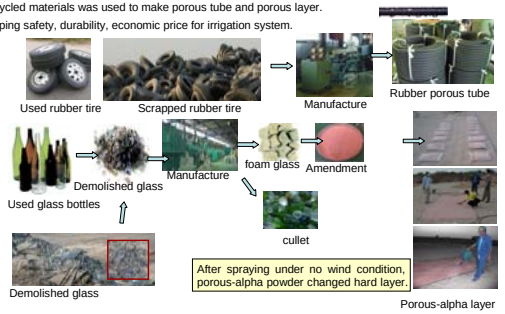


Spreading patterns of water content under drip irrigation depends upon clayey, loamy and sandy soils. Percolation in sandy soil should be larger than others.

Using durable materials for sustainable agriculture

Recycled materials was used to make porous tube and porous layer.

Keeping safety, durability, economic price for irrigation system.



Materials and methods

The experiment was conducted and replicated four times in a sandy soil under greenhouse condition using sub-surface irrigation system. Treatments consisted of 2cm thickness porous-Alpha and 10cm thickness placed in 20cm depth in the soil. The control soil received no treatment. Irrigation amount was 50% of small pan evaporation, Soil water content was measured every 1 hour by SM200 (Delt-T Co. Ltd.) at 18 and 25 cm depth.

(Swiss chard in greenhouse experiment)

Treatments: Two porousa layers of 2cm and 5cm thickness and control.

Swiss chard was sown in a pot on 20 April, 2008

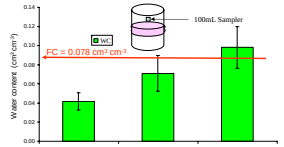
(Japanese Green Mizuna in greenhouse experiment)

Experiment was set in the block with 70cm width, 90cm length and 50cm depth by sub-surface rubber porous tube at 5cm depth. Porous-alpha layer of 2cm thickness was set at 20cm depth.

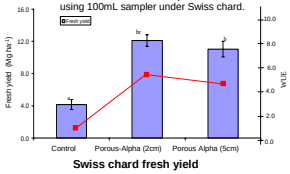
(Tomato in greenhouse experiment)

Water content was measured every 1 hour interval by ADR sensor (SM200, Delta-T) inserted at 15cm depth and data logger (DL6, Delta-T). Tomato was planted on 1 May, 2009 and harvested on 15 Aug., 2009. Daily irrigation was equivalent to 50% of open-pan evaporation.

Results and discussions



Water content at 15 cm depth measured using 100mL sampler under Swiss chard.



Swiss chard fresh yield

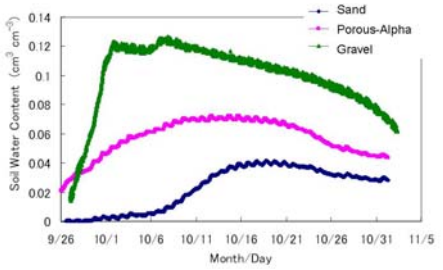
Swiss chard experiment

Fresh yield was higher under porous layer of 2cm thickness and 5cm thickness treatments, obtained at 12.09 and 11.05 Mg/ha, respectively. Fresh yield 4.15 Mg/ha under the control was significantly lower. Water use efficiency under control, 2cm thickness, 5cm thickness treatment was 1.07, 4.91, 4.49 g/L, respectively.

Control Porous-Alpha (2cm)

Japanese Green Mizuna

Mizuna was grown well under gravel treatment. Fresh Mizuna yield was significantly difference (14.6 g/plant) as compared to other treatment.

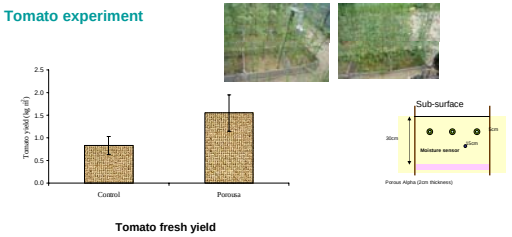


Comparison of soil water content at the depth of 18cm with time between sand, 2cm-porous-Alpha and 10cm-Gravel layer

The water content was significantly differences; the average value was 0.12, 0.09 and 0.04 $cm^3\ cm^{-3}$ for gravel, porous-Alpha, control, respectively.

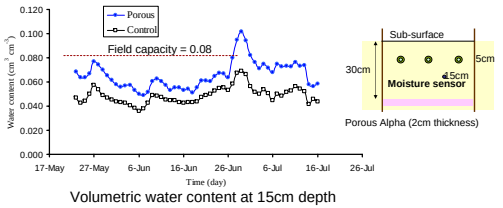
Thus, results demonstrated that the gravel was significantly difference fallowed by porous-Alpha indicating the possibility of these treatments to increase water capillary barrier and keep more water in root zone.

Tomato experiment



Tomato fresh yield

Tomato fresh yield of 1.54 kg m^{-2} under porous-alpha treatment was better than control (0.83 kg m^{-2}).



Volumetric water content at 15cm depth

The fact, that water content in Tomato root zone under porous layer was about 0.02 $cm^3\ cm^{-3}$ larger than control, implied that plant was growing better under porous layer treatment.

Conclusions

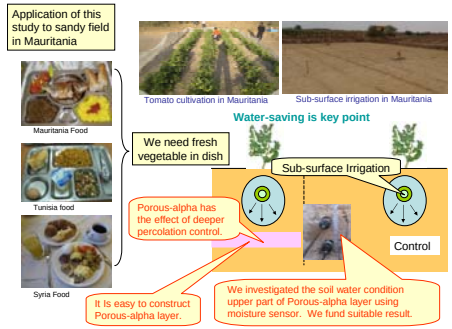
This study evaluated the effect of different porous-alpha layers on water availability in sandy soil.

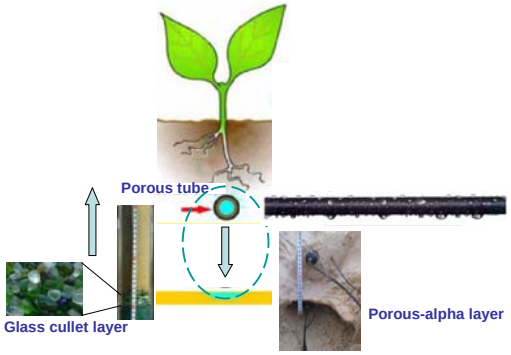
A measure of fresh yield and water use efficiency of Swiss chard grown in a sand dune with the amendment of two different layers of porous-alpha indicated that this treatment could improve crop production and water availability.

Low yield fresh observed at the control is attributed to the low water holding capacity and rapid percolation losses in dune sand.

In general, we conclude that a layer of the porous-alpha can be used to irrigate vegetables grown in sandy soils of semi-arid regions at input levels equivalent to 50% of pan evaporation.

We recommend the use of a sub-surface irrigation system for such an irrigation option in sandy soils.





to prevent salt accumulation by the groundwater rising

Upward flow by the capillary rise was stopped by capillary barrier using cullet as shown in left picture.

References

Ould Ahmed, B.A. and Inoue, M.: Increasing crop productivity using a porous α amendment in sandy soil, Journal of Food, Agriculture & Environment, 7(2): 546-550 (2009)

*1 Address: 1390Hamasaka,Tottori,680-0001,JAPAN

Keywords: Sub-surface seepage rubber tube, porous layer recycled from used glass bottles, Water holding capacity, vegetable cultivation in sand soil. (ASA-CSSA-SSSA 2009 International Annual Meetings, Pittsburgh, Pennsylvania, USA, Nov.1-5)