Study on effects of deficit irrigation on growth, yield and water use efficiency of Tomato

○Dianmei Gao*, Masateru Senge**, Kengo Ito**

1 Introduction The increasing need of crop production for growing population is causing rapid expansion of irrigation throughout the world. On the other hand, severe water scarcity presents the biggest threat to future food production. Tomato is one of the most widely grown vegetables in the world because of special nutritive value of its fruit. At the same time, tomato is a kind of high water demanding crop, and requires irrigation throughout growing season. The aim of this study was to assess yield, quality, biomass and *WUE* (water use efficiency, *WUE*=product (g) /water consumption (kg)) of greenhouse-cultivated tomato under Full and Deficit irrigation.

2 Materials and methods Experiment was conducted in glass house with open surrounding sides, located in the experimental farm of Gifu University (35°27′N. and 136°44′E.), Japan, from May to August 2011. Organic soil for horticultural plantation cultivation was taken as substrate to process experimental tomato crop with pots. In completely randomized block design with 5 replicates, four irrigation treatments were studied (**Fig.1**). The cultivar Pepe (cultivar of mini-tomato in Japan) of processing tomato was used for experiment. The factor of this experiment was four different irrigation levels, set according to pF curve of substrate, namely: $I_{100\text{-}75}$, $I_{75\text{-}50}$, $I_{50\text{-}25}$ and $I_{25\text{-}0}$. The $I_{75\text{-}50}$, as an example, means the water content must be kept 50% to 75% of the total available water (*TAW*). And when the water content was found lower than 50% of *TAW*, it must be irrigated to the 75% of *TAW*. *TAW* is defined as the water content between field capacity (*FC*) and permanent wilting point (*PWP*).

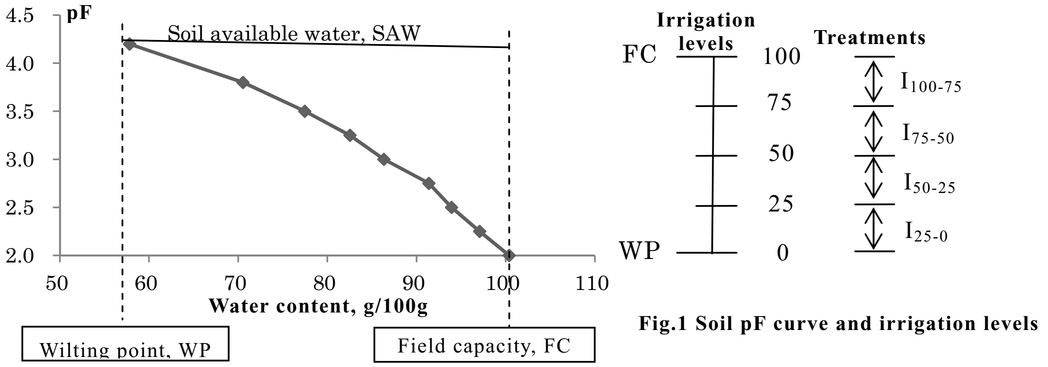

Fig.1 Soil pF curve and irrigation levels

3 Results and discussion

3.1 The evapotranspiration of tomato plant during deficit irrigation period

The evapotranspiration(ET, g/d) of tomato plant under four different treatments has positive relationship with the decreasing irrigation levels after deficit irrigation began on June 21 (**Fig.2**). But there was also no significant difference of ET among different irrigation treatments on rainy day, like on July 8 and July 27.

*Graduated School of Applied Biological Science, Gifu University
**Faculty of Applied Biological Science, Gifu University
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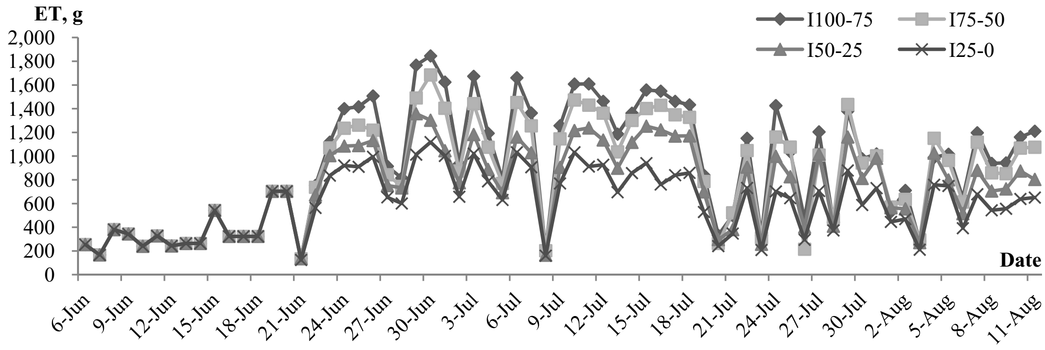

Fig.2 The evapotranspiration (ET, g/Day) of tomato plant during deficit irrigation period

3.2 Yield of each plant at four fruit sets

Yield decreased with the deficit irrigation (DI) levels, as $I_{100\text{-}75}$, $I_{75\text{-}50}$, $I_{50\text{-}25}$ and $I_{25\text{-}0}$ with the yield of 507.4g, 451.8g, 345.2g and 239.0g per plant separately. At the same time, total yield of each fruit set also had a trend of decreasing DI levels.

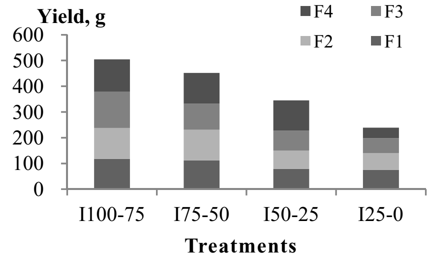

Fig.3 Yield of each plant at different

3.3 Fruit sugar content analyses

According to **Fig.4**, fruit of $I_{25\text{-}0}$ had the highest sugar content through the whole growth period, followed by $I_{75\text{-}50}$, $I_{50\text{-}25}$ and $I_{100\text{-}75}$. Deficit water supply made the water content decrease down, conversely, sugar content was going up. Based on the result, deficit irrigation (DI) could increase fruit quality at sugar content.

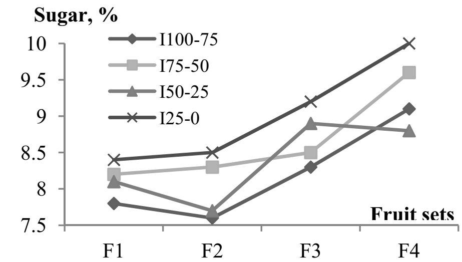

Fig.4 Fruit sugar content of different four fruit sets

3.4 Water consumption and water use efficiency

Water consumption (WC, kg) per plant through the whole processing life of tomato was decreasing with the irrigation levels, with the full irrigation treatment 61.8kg but only 41.0 kg under $I_{25\text{-}0}$. Yield efficiency (WUEey, g/kg) value trended to decrease with DI, but there were no significant differences between full irrigation ($I_{100\text{-}75}$) and the 25% of soil available water DI ($I_{75\text{-}50}$). Biomass accumulation efficiency (WUE_{tb}, g/kg) had negative correlation to different irrigation levels, although there was no significant difference between $I_{100\text{-}75}$ and $I_{75\text{-}50}$. Therefore, $I_{75\text{-}50}$ irrigation strategy could save a part of water (4.8 kg) without much change on WUE_{ey} and WUE_{tb}.

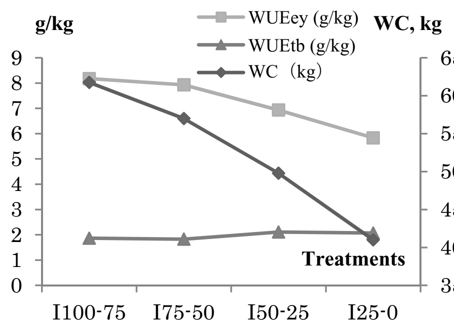

Fig.5 Water use efficiency at yield level and total biomass level, WUE_{ey} & WUE_{tb}

4. Conclusion From these results, there were significant effects of water stress on yield, growth situation and WUE of $I_{50\text{-}25}$ and $I_{25\text{-}0}$, but no significant effects on $I_{75\text{-}50}$. Further study is needed to examine the effect of deficit irrigation and to elucidate the underlying mechanism.