The effect of soil water deficit on transpiration in spring wheat subject to elevated temperature and CO_2 concentration

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The dry matter production (DMP) for one time interval is indicated by

$$DMP = WUE \times T/VD \quad (1)$$

where WUE is water use efficiency, T transpiration and VD vapor deficit (Tanner and Sinclair, 1983). When plants are well irrigated, DMP_0, WUE_0, and T_0/VD are given. The ratio of DMP to DMP_0 is

$$DMP/DMP_0=(WUE/WUE_0)\times(T/VD)/(T_0/VD)$$
$$=(WUE/WUE_0)\times(T/T_0) \quad (2)$$

$$DMP=DMP_0\times(WUE/WUE_0)\times(T/T_0) \quad (3)$$

In diverse crop plants the WUE/WUE_0 scarcely changed with soil desiccation and was similar among cultivars but the T/T_0 was severely suppressed by soil desiccation (Tanner and Sinclair, 1983; Kobata et al., 1996). Hence the response of T/T_0 to soil desiccation is one of the most important factors deciding the DMP. The DMP_0 is considered as a potential productivity under well irrigated condition. The DMP_0 is expected to be estimated from a simulation model (Nakagawa and Horie 1997).

Empirically there was a close curve liner relationship between normalized transpiration rate (T/T_0) and fraction of transpirable soil water (FTSW) in most crop species. The FTSW is ratio of soil water to transpirable soil water (Ray and Sinclair, 1998). Hence T/T_0 is the important factor to estimate the suppression of DMP_0 under soil desiccated conditions.

However, it is unknown the effect of soil water deficit on T/T_0 in spring wheat subject to elevated temperature and CO_2 concentration.

MATERIALS and METHODS

Adana99 from Mediterranean area, during the late vegetative stage was grown in pots under glass house condition, and suffered elevated temperature and CO_2 condition in growth cabinet of Tottori Dryland Research Center after one week naturalization. Temperature in ambient chamber was 20/15 °C, day time vapor deficit 11.9 g m^{-3} and CO_2 concentration 414±20 μmol l^{-1} and in an elevated chamber temperature 24/19 °C, day time vapor deficit17.4 g m^{-3} and CO_2 concentration 589±27 μmol l^{-1}. Water use was measured every day and transpiration was estimated with weighing method.

RESULTS and DISCUSSION

Transpiration rate decreased with decrease in soil water contents and there was a curve liner relationship between relative transpiration rate (soil desiccated/irrigated control) and fraction transpirable soil water.

The relationship under ambient and elevated conditions was similar (Fig.1). In this experiment the relationship was taken from more diverse range of soil water content than a past result. The relationship will be used as a submodel to estimate suppression of biomass production by soil desiccation under elevated conditions.

Water use efficiency of plants suffered from soil desiccation in elevated conditions increased from ambient conditions (Fig. 2). The effect of elevated CO_2 condition on water use efficiency should be investigated from accurate experiment.

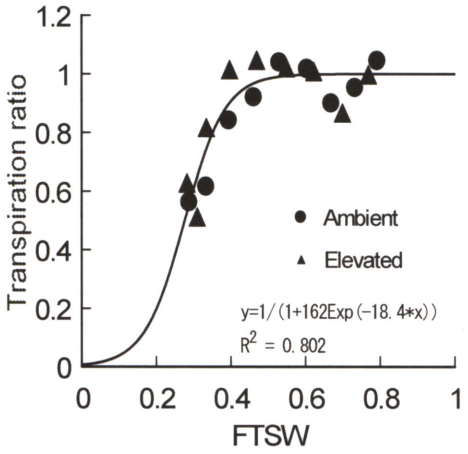

Fig.1. Transpiration ratio (soil desiccated/irrigated) and FTSW in Adana99 under ambient and elevated temperature and CO_2 concentration during late vegetative stage. FTSW is fraction transpirable soil water.

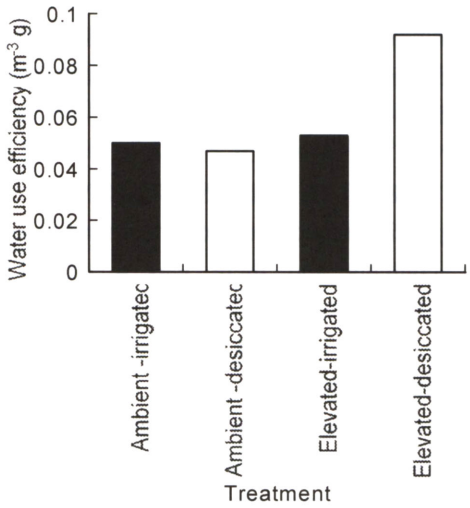

Fig. 2. Water use efficiency in Adana99 plants suffered from soil desiccation under ambient and elevated conditions. Transpiration rate was corrected by day time vapor deficit.

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