

Oxygen Release Compound Alleviates Injuries of Chrysanthemum under Waterlogging and High Temperature Conditions

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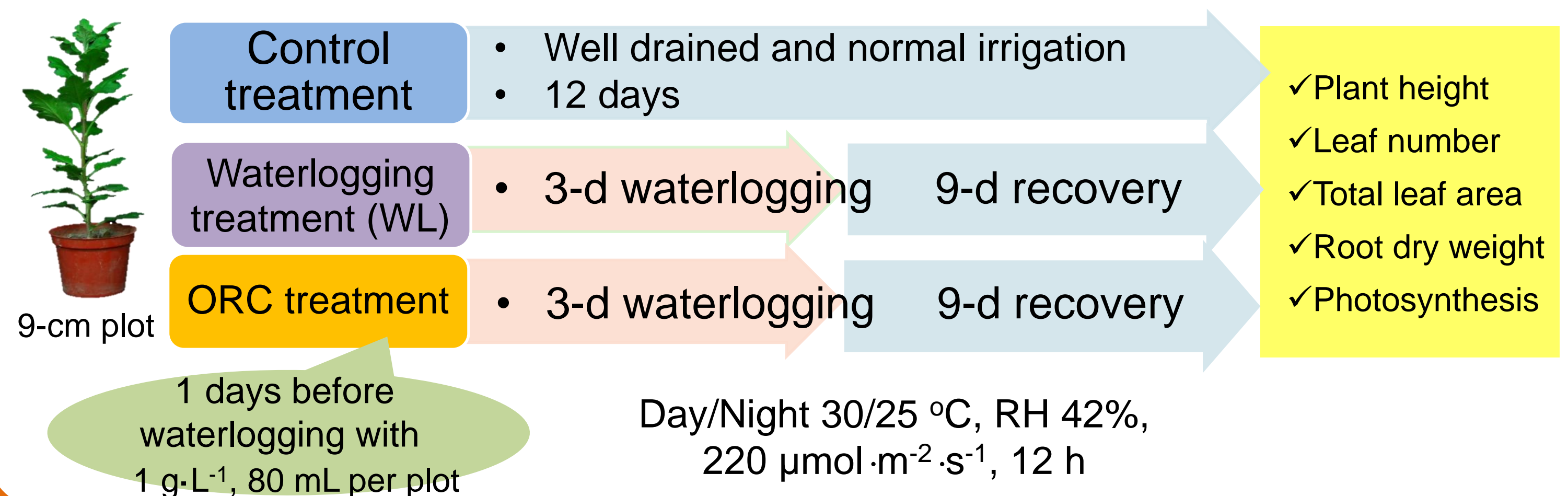
Abstract

Heavy summer rain in subtropical and tropical areas causes soil hypoxia, which is detrimental to field-grown chrysanthemums [*Dendranthema grandiflorum* (Ramat.) Kitam.]. Oxygen release compound (ORC), mainly composed of magnesium peroxide (MgO_2), may alleviate injuries of chrysanthemum under waterlogging as ORC can release oxygen when desolved in water. The effects of ORC on growth and photosynthesis were studied in two chrysanthemum cultivars, waterlogging-tolerant 'Huang Gin-Ging' and waterlogging-intolerant 'Kaa Dei-Na'. Vegetative young plants with 14-16 leaves were placed in a growth room at 30/25 °C and 12 h photoperiod with an average light intensity $220 \mu mol \cdot m^{-2} \cdot s^{-1}$. Plants were subjected to three treatments: normal irrigation (control), waterlogging treatment (3-day waterlogging followed by 9-day recovery), and ORC treatment (80 mL of $1.0 g \cdot L^{-1}$ ORC solution applied to the medium one day before the waterlogging treatment). Results showed that control plants of both cultivars grew well and maintained high photosynthesis rates. As compared with control, waterlogging treatment caused more root dry weight reduction in 'Kaa Dei-Na' than 'Huang Gin-Ging' (52.3% vs. 7.8%). Plants of 'Huang Gin-Ging' at waterlogging or ORC treatments did not differ in growth and exhibited a declined net photosynthesis (Pn) at Day 3 but a recovered Pn at Day 12. In contrast, 'Kaa Dei-Na' at ORC treatment had greater shoot length and root dry weight, consistently higher Pn and lower intercellular CO_2 concentration (C_i) than those at waterlogging treatment. ORC application prior to waterlogging resulted in increased growth and Pn and alleviated the injury of waterlogging-intolerant 'Kaa Dei-Na'.

Introduction

Chrysanthemum is one of the most important floriculture crop in the world. Heavy rain and high temperature in summer causes soil hypoxia, resulting in poor growth of field-grown chrysanthemum. Oxygen depletion can occur within few hours. Root system is the first to suffer from oxygen shortage. Oxygen release compound (ORC), mainly composed of MgO_2 , may reduce damage under waterlogging as ORC can release oxygen when desolved in water. We studied the effect of ORC on growth and photosynthesis of two chrysanthemum cultivars subjected to waterlogging and high temperature conditions.

Materials and Methods



Results

- Plants without waterlogging grew well during the experiment (Fig. 1).
- Waterlogged plants exhibited leaf wilting and much reduction of shoot and root growth in 'Kaa Dei-Na' but not 'Huang Gin-Ging' (Fig. 1).
- The growth of 'Kaa Dei-Na' improved when pretreated with ORC (Fig. 1B).

- In 'Huang Gin-Ging' whether pretreated with ORC, Pn, stomatal conductance, and transpiration rate all decreased after 3-d waterlogging but recovered at 9-d recovery (Fig. 2).
- Plants with ORC had higher Pn and lower C_i as compared to waterlogged plants without ORC (Fig. 2A, B, G, H).

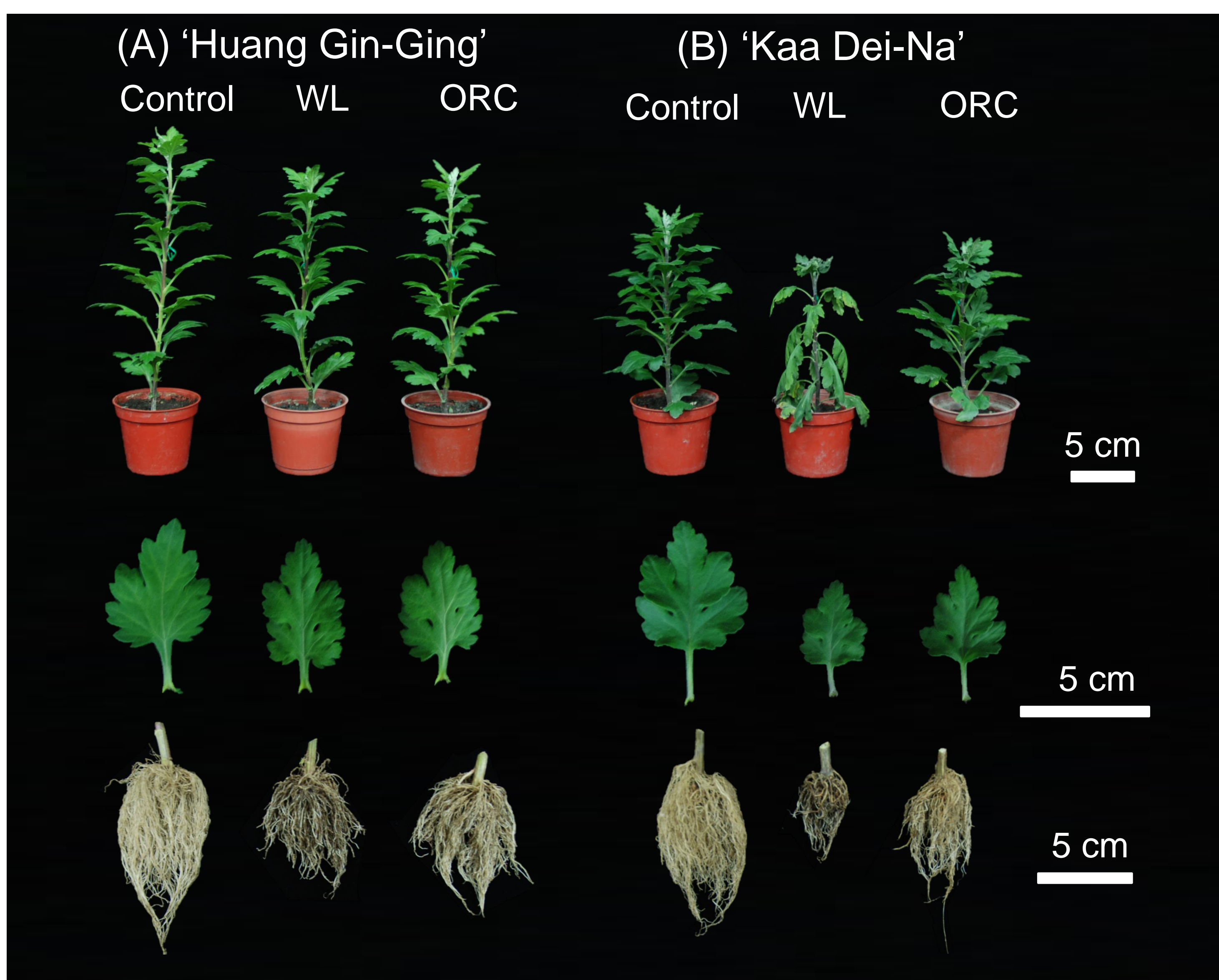


Fig. 1. Effect of pretreatment with $1 g \cdot L^{-1}$ ORC on growth of 'Kaa Dei-Na' subjected to 3-day waterlogging followed by 9-day recovery at 30/25 °C.

Table 1. Effects of pretreatment with $1 g \cdot L^{-1}$ ORC on plant height, leaf number, leaf area, root dry weight and reduced root dry weight of two chrysanthemum cultivars subjected to 3-d waterlogging followed by 9-d recovery at 30/25 °C.

Cultivar	Treatment ^z	Plant height (cm)	Leaf number	Total leaf area (cm ²)	Root dry weight (mg)	Reduced root dry weight (%)
Huang Gin-Ging	Control	26.2 a ^y	22.8 a	278 a	308 a	
	WL	22.5 b	21.2 b	218 b	284 a	7.8
	ORC	23.2 b	22.0 ab	227 b	278 a	9.6
Kaa Dei-Na	Control	18.1 a	25.5 a	299 a	276 a	
	WL	15.6 c	23.3 a	217 b	131 c	52.3
	ORC	16.7 b	24.7 a	248 b	191 b	30.6
Cultivar (C)		***	***	NS	***	
Treatment (T)		***	**	***	***	
C × T		NS	NS	NS	*	

^zControl = well drained and without oxygen release compound; WL = waterlogging for 3 d followed by 9-d recovery; ORC = Plants were pretreated with 80 mL of $1 g \cdot L^{-1}$ oxygen release compound to growing medium 1 d before waterlogging.

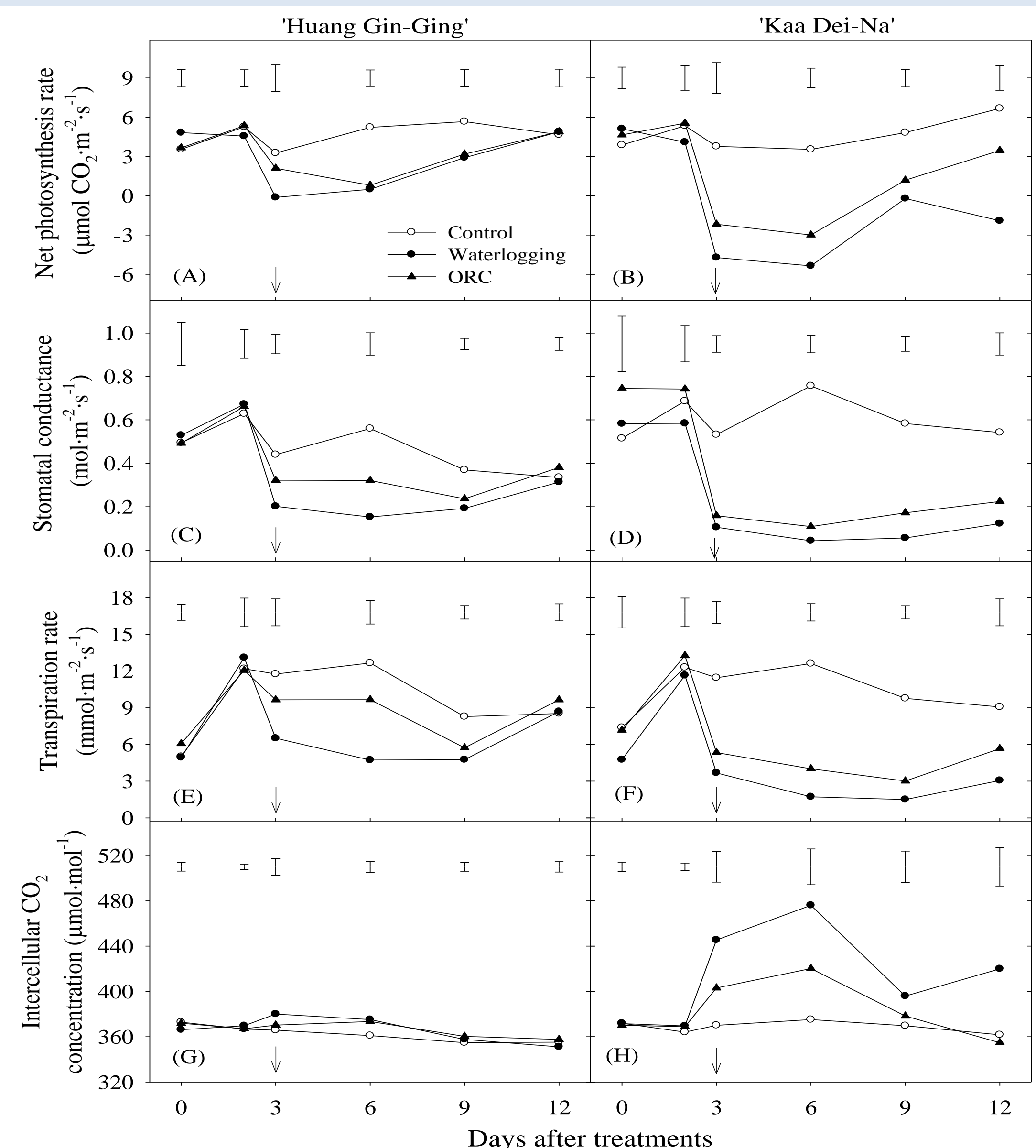


Fig. 2. Effects of pretreatment with $1 g \cdot L^{-1}$ oxygen release compound on (A, B) net photosynthesis rate, (C, D) stomatal conductance, (E, F) transpiration rate, and (G, H) intercellular CO_2 concentration of two chrysanthemum cultivars subjected to 3-day waterlogging followed by 9-day recovery at 30/25 °C.

« Plant height, root dry weight of 'Kaa Dei-Na' pretreated with ORC were higher than waterlogging treatment (Table 1).

Conclusions

- Plant growth of 3-d waterlogged 'Huang Gin-Ging' did not differ among treatments.
- ORC pretreatment enhanced waterlogging-tolerance of 'Kaa Dei-Na' through more root dry weight, higher Pn, and lower intercellular CO_2 concentration.