

Pn-PAR and CO₂ Responses of *Prunus avium* to Drought Stress during Hard Nucleus Stage

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Abstract: Aim at the drought, one of the important stress factors, we chose the *Prunus avium* named ‘Hong Deng’ to experiment. Through artificial control field soil water content, to different drought stress treatment of sweet cherry, we collected the changes under different drought stress, including characteristics of CO₂ response curve and Pn-PAR response during hard nucleus stage of fruit. Provide some knowledge of *P. avium* under drought stress.

Introduction

Prunus avium which is the sweet cherry is native to the coasts of the Caspian Sea and Western Asia, and it has developed into an important economic fruit in the Western Sichuan Province north of the Minjiang River Valley [1]. It has a large content of iron, calcium and other mineral, the content of vitamin C in 100 g pulp is 7-13 mg [2]. Because of the high economic benefits, the growers are very fond of it. The drought is an important adversity factor that affects the normal development of plants [3-4]. China has a wide range of arid regions, the characteristics of high frequency, and long duration and great destructive force have seriously affected the development of the planting industry. Therefore, in recent years, researchers have paid more attention to the study of drought stress physiology of fruit trees, and Wu et al. [5] studied the effect of different soil moisture content on the photosynthetic characteristics of *Robinia pseudoacacia*. The results showed that the maximum photosynthetic rate, the effective radiation range, net photosynthetic rate, transpiration rate and stomatal conductance of *R. pseudoacacia* decreased with the decrease of soil moisture content. The purpose of this experiment is to provide some knowledge of the *P. avium* under drought stress.

Materials and Methods

Materials Collection. The experiment was conducted in Mao County Orchard in Aba Tibetan and Qiang Autonomous Prefecture in Sichuan Province, Test materials selected ‘Hong Deng’ *P. avium* was planted in 2009, Consistent growth and development.

Experimental Design. Before cheery sprout, the test field moisture content has been determined by water-refilling and water-controlling. Every 7 days sample soil’s relative moisture content is tested in order to make that of test plants aborting water field to reach 4 gradients: mild drought (LD), moderate drought (MD), severe drought (SD) and contrasting CK (soil relative water content for the 55% to 60% of field capacity, the 40% 45% of field capacity, 30% to 35% of water holding capacity of farmland and 75% to 80% of field capacity). This is to enable sweet cherry to have different drought threatening reactions. Put transparent plastic ground film under test plants to cover test field trees; to avoid soil moisture horizontally moving, dig a 60-cm-deep anti-lateral-seepage ditch 1 cm under the drip line and bury anti-lateral-seepage plastic thin film. Conduct this to each single plant and repeat three times. The Li-6400 xt portable photosynthetic apparatus was used to determine the determination [6-7].

Results and Discussion

Pn-PAR Response. Using nonrectangular hyperbolic model to fit the light response curve, obtain the apparent quantum yield, maximum net photosynthetic rate, dark respiration rate, light compensation point and light saturation point of each processing (Table 1, Fig. 1).

Table 1 The parameter of Pn-PAR Response to drought stress

Treatments	AQY ($\mu\text{mol CO}_2 \cdot \text{m}^{-2} \cdot \text{s}^{-1}$)	$P_{n\text{max}}$ ($\mu\text{mol CO}_2 \cdot \text{m}^{-2} \cdot \text{s}^{-1}$)	LCP ($\mu\text{mol photons} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$)	LSP ($\mu\text{mol photons} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$)	R_d ($\mu\text{mol CO}_2 \cdot \text{m}^{-2} \cdot \text{s}^{-1}$)	R^2
CK	0.053	19.204	33.162	465.685	1.645	0.995
LD	0.059	14.072	16.216	392.947	0.819	0.994
MD	0.057	13.564	15.120	385.532	0.779	0.997
SD	0.035	7.066	21.422	305.198	0.723	0.997

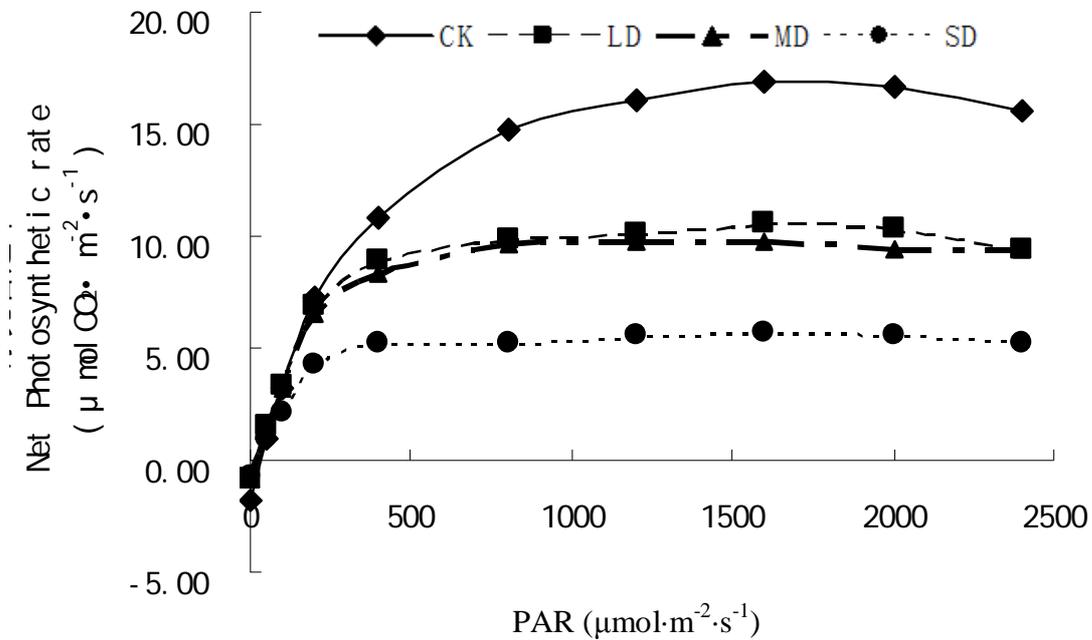


Fig. 1 The parameter of Pn-PAR Response curve to drought stress

CO₂ Response Curve. The carboxylation efficiency, photosynthetic capacity, photorespiration rate, CO₂ compensation point and CO₂ saturation point of each treatment is obtained by fitting the CO₂ response curve with a right angled hyperbolic model (Table 2, Fig. 2).

Table 2 The parameter of CO₂ response to drought stress

Treatments	CE ($\mu\text{mol CO}_2 \cdot \text{m}^{-2} \cdot \text{s}^{-1}$)	Pm ($\mu\text{mol CO}_2 \cdot \text{m}^{-2} \cdot \text{s}^{-1}$)	CCP ($\mu\text{mol CO}_2 \cdot \text{mol}^{-1}$)	CSP ($\mu\text{mol CO}_2 \cdot \text{mol}^{-1}$)	Rp ($\mu\text{mol CO}_2 \cdot \text{m}^{-2} \cdot \text{s}^{-1}$)	R^2
CK	0.0403	35.66	52.85	937.72	3.206	0.983
LD	0.0363	31.13	59.37	916.94	2.982	0.981
MD	0.0357	21.65	60.62	667.06	2.739	0.980
SD	0.0277	12.42	70.47	518.84	2.397	0.992

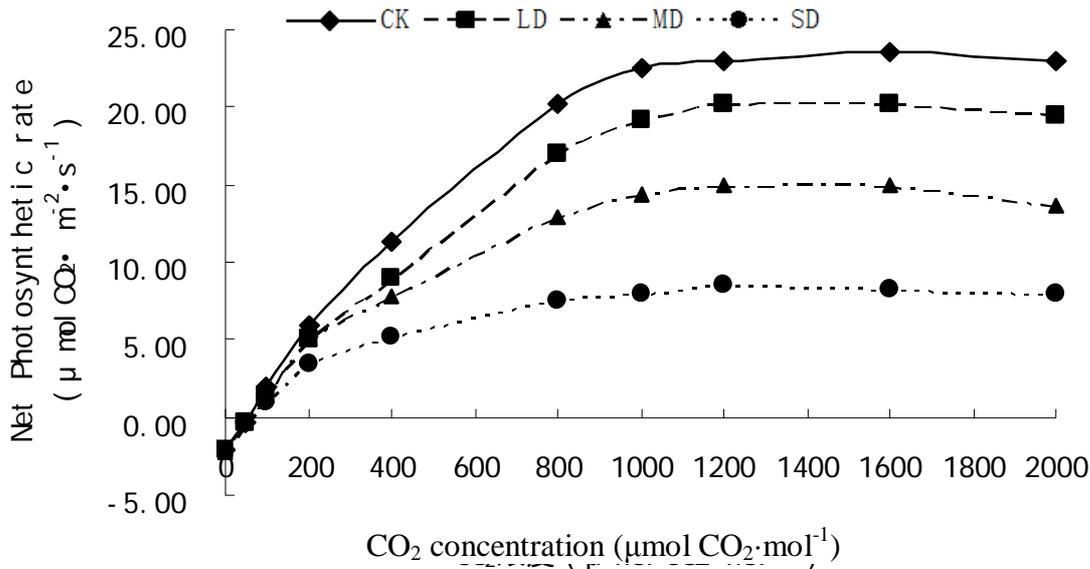


Fig. 2 The parameter of CO₂ response curve to drought stress

The data showed that, first, the AQY of the LD treatment group under drought stress was the maximum $0.059 \mu\text{mol CO}_2\cdot\text{m}^{-2}\cdot\text{s}^{-1}$, followed by that of the MD treatment group $0.057 \mu\text{mol CO}_2\cdot\text{m}^{-2}\cdot\text{s}^{-1}$, and that of the SD treatment group the minimum $0.035 \mu\text{mol CO}_2\cdot\text{m}^{-2}\cdot\text{s}^{-1}$. Second, Pn max ($19.204 \mu\text{mol CO}_2\cdot\text{m}^{-2}\cdot\text{s}^{-1}$), LSP ($465.685 \mu\text{mol photons}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$) and Rd ($1.645 \mu\text{mol CO}_2\cdot\text{m}^{-2}\cdot\text{s}^{-1}$) were the maximum in CK control group, and the Pn max, LSP and Rd of LD, MD and SD treatment groups decreased with the increase of drought stress. Third, the range of available light intensity of each treatment group was significantly different; the range of light intensity of the CK control group was the widest $33.162\text{--}465.685 \mu\text{mol photons}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$, and that of the SD treatment group the narrowest $21.422\text{--}305.198 \mu\text{mol photons}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$.

Conclusions

Drought stress can reduce the Pn max, LSP and Rd of sweet cherry, narrow the range of available light intensity; moderate drought stress can increase AQY, that is, increase utilization of sweet cherry on low light. Meanwhile, under the drought stress, the CE of the CK control group was the maximum $0.0403 \mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$, followed by that of the LD and MD treatment groups, respectively, which were 0.0363 , $0.0357 \mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$, and that of the SD treatment group the minimum $0.0277 \mu\text{mol CO}_2\cdot\text{m}^{-2}\cdot\text{s}^{-1}$. The Pm of the CK control group was the maximum $35.66 \mu\text{mol CO}_2\cdot\text{m}^{-2}\cdot\text{s}^{-1}$, with the widest range of the available CO₂ concentration $52.85\text{--}937.72 \text{ mmol}\cdot\text{mol}^{-1}$ and the highest Rp $3.206 \mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$.

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