Photosynthesis and transpiration of Chicory with different irrigation treatments in Beijing

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Introduction Water deficit usually influences photosynthesis , causing stunted growth and development , and futher reduces yield of forage (Flexas et al . 2004) . Knowledge gained from studying photosynthesis and transpiration of chicory at different irrigation levels is essential for growing plants in a water stressed area like Beijing .

Materials and methods The experimental site , with a mean temperature of 12 .2 ℃ and an average annual precipitation of 518 .3 mm , was located in Shunyi County in the northeast of Beijing . Chicory was seeded in spring at a rate of 12 kg/hm^2 . The plot area with 3 replications was 5m×10m each , and the space between plots was 2 m . Buffer areas were covered by plastic film to prevent water infiltration . Three different irrigation treatments of 60 mm (CK , 600 m^3/hm^2) , 40 mm (MS) , and 20 mm (SS) water were applied for regrowth after 4 and 5 mowings in 2002 and in 2003 , respectively . The diurnal changes of photosynthesis (Pn) and transpiration (Tr) of chicory were measured for the different treatments and different stages of leaf , bolting , and budding using CIRAS-1 Cassettes Photosynthesis System (PPS Co . , Ltd . , UK) . On sunny days , four mature leaves of chicory in each plot were selected randomly to measure every 2 hours from 08 :00 to 18 :00 and to calculate the average Pn and Tr .

Results The diurnal change of leaf Pn showed the *S*" shape with the first peak occurring at 10 :00 , the second at 14 :00 , and the trough at 12 :00 . The diurnal change of Tr was similar to Pn , but peaks and the trough were delayed by 1-2 hours compared with Pn . The average Pn and Tr changes (Table 1) showed soil water content had a great influence on photosynthesis and transpiration of chicory's leaves . A quadratic relationship existed between the Pn and Tr at the different soil water contents . CK : $Pn=-0.3365\times Tr^2+8.4787\times Tr-34.453$ ($R^2=0.5563$, $P<0.05$) ; MS : $Pn=-0.3287\ Tr^2+7.8767\times Tr-30.757$ ($R^2=0.5415$, $P<0.05$) ; SS : $Pn=-0.0414\times Tr^2+1.7927\times Tr-3.8072$ ($R^2=0.4274$, $P<0.05$) , due to the effects of stomatal movement on both rates and the lag in response of transpiration (Gao 1999) .

At low soil water levels , the stoma closed in order to decrease water loss from chicory's leaves . It appeared the response of chicory to the water shortage at the bolting stage and bud stage were more sensitive than that at the leaf stage . The results showed that a quadratic relationship existed between Pn and Tr , and it was essential if normal photosynthesis and transpiration were to occur , plants needed irrigation for regrowth after each harvest in Beijing .

Table 1 *The Pn and Tr of chicory's leaves at different irrigation treatments .*

	treat-ments	leaf stage			bolting stage			bud stage		
		average	peak	trough	average	peak	trough	average	peak	trough
Pn μmol $CO_2\cdot m^{-2}\cdot s^{-1}$	CK	17 .93± 1 .03^a	28 .12± 0 .74^a	19 .15± 0 .81^a	12 .83± 1 .62^a	21 .60± 1 .25^a	12 .96± 1 .49^a	14 .07± 1 .11^a	25 .80± 0 .75^a	14 .58± 0 .84^a
	MS	15 .17± 0 .88^a	26 .57± 0 .63^a	15 .93± 0 .67^b	10 .90± 1 .56^a	19 .73± 1 .14^a	11 .55± 1 .35^a	11 .64± 0 .92^b	23 .33± 0 .67^a	10 .72± 0 .62^b
	SS	7 .51± 0 .43^b	18 .05± 0 .36^b	5 .68± 0 .38^c	6 .30± 1 .04^b	15 .24± 0 .88^b	5 .65± 0 .96^b	6 .51± 0 .33^c	16 .55± 0 .33^b	5 .15± 0 .30^c
Tr mmol H_2O/ ($m^2\cdot s$)	CK	10 .74± 0 .62^a	14 .68± 0 .66^a	11 .79± 0 .56 ^{a}	11 .39± 0 .68^a	15 .88± 0 .85^a	11 .79± 0 .48 ^{a}	11 .76± 0 .92^a	15 .93± 0 .92^a	12 .15± 0 .45 ^{a}
	MS	10 .27± 0 .59^a	13 .74± 0 .60^a	10 .92± 0 .78 ^{a}	10 .38± 0 .59^a	14 .23± 0 .79^a	10 .30± 0 .39 ^{a}	10 .31± 0 .82^a	14 .11± 0 .81^a	9 .93± 0 .52 ^{ab}
	SS	5 .73± 0 .33^b	8 .64± 0 .40^b	5 .38± 0 .35 ^{b}	7 .01± 0 .44^b	10 .38± 0 .50^b	7 .01± 0 .70 ^{b}	7 .72± 0 .60^b	11 .03± 0 .64^b	7 .34± 0 .20 ^{b}

Note : average-average of Pn from 08 :00 to18 :00 ; peak-Pn of 10 :00 ; trough-Pn of 12 :00 . average-average of Tr from 08 :00 to 18 :00 ; peak-Tr of 12 :00 ; trough-Tr of 14 :00 . Different superscript letters in the same column indicate the significant difference at a $P<0.05$ level .

References

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