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Analysis and Study on Photosynthetic Physiological Characteristics of 4 Grass Species in Karst Rocky Desertification Area

[1]Yong Kuan Chi, [1]Kang Ning Xiong, [1]Pan Di Zhao,
[1,2]Jin Hua Zhang, [1,3]Yuan Su Wang and [4]Wen Long Zhou
[1]South China Institute of Karst, Guizhou Normal University, 550001 Guiyang, China
[2]Institute of Animal Husbandary and Veterinary, Ghizhou Province, 550005 Guiyang, China
[3]Guizhou Provincal Grassland Monitoring Station, 550001 Guiyang, China
[4]Institute of Mountain Resource, Guizhou Province, 550001 Guiyang, China

Abstract: This study studies the net photosynthesis rate, transpiration rate and water-use efficiency of four forage grasses as *Bromus cartharticus* Vahl and *Festuca elata* ex E., *Dactylis glomerata* L. and perennial *Lolium perenne* L. on fine days in Bijie Salaxi Karst rocky desertification control area of Guizhou Normal University. The results showed that the average daily water use efficiency ranks: (from high to low) *Festuca elatal* ex. E., *Bromus cartharticus* Vahl, *Dactylis glomerata* and perennial *Lolium perenne* L. In detail, the average daily photosynthetic and transpiration rates of *Festuca elatal* ex E. are 6.234.53 (μ moL/(m^2 sec)) and 6.23 (mol/(m^2 sec)), respectively which belongs to high photosynthesis, high transpiration type. On the contrary, *Bromus cartharticus* Vahl, *Dactylis glomerata* L. and perennial *Lolium perenne* L. belong to low photosynthesis, low transpiration type. The average daily photosynthetic and transpiration rates are 4.87, 4.71, 4.53 (μmol/(m^2 sec)) and 4.29, 4.42, 4.83 (mol/(m^2 sec)), respectively. Net photosynthesis rate, transpiration rate and water use efficiency should be considered when researchers plant artificial pasture in Karst rocky desertification area. Meanwhile, different pasture allocation measures can not only reduce transpiration and water loss but also increase water use efficiency. These measures could ease the current situation of water shortage in Karst rocky desertification area. Both of changing the current planting situation of single sowing grass and conducting the mixture sowing between leguminous forage and herbage with high and low photosynthetic rate and transpiration rate are helpful for the diversity of biological populations in Karst rocky desertification area and improving the production potential of herbage.

Key words: Karst, rocky desertfication, Poaceae, net photosynthetic rate, transpiration rate, water use efficiency, diurnal variation

INTRODUCTION

The Southwest China Karst region, Guizhou Province as its geographical center, includes most of Guizhou Province and part areas of Guangxi, Yunnan, Sichuan, Chongqing, Hubei, Hunan Provinces and so on with the area of >55×10^6 km^2. It's an ecological fraile area and develops most typically with biggest area in global three concentrated Karst areas (Shijie, 2003; Yuan, 2001; Xiong *et al*., 2006). Karst rocky desertification is the most serious ecological disaster in Southwest China (Zhong *et al.* 2003; Yuan, 1997; Wang *et al*., 2004; Cao and Yuan, 2005; Wang and Li, 2005; Huang and Cai, 2005; Bai *et al*., 2009; Huang and Ren, 2011) which is closely related to 1.0×10^8 populations (Shijie, 2003; Yuan, 2001; Xiong *et al*., 2006). After many years of practice by relevant experts, it has been proved that plating grass and stock keeping on the slopes in rocky desertification area can not only increase the farmers' income but also protect the ecological environment, effectively curbing the rocky desertification expansion (Huang and Ren, 2011). The development of grassland animal husbandry is an important measure to enrich the farmers in rocky desertification area in short time, improve the ecological environment and realize the sustainable development of society and economy (Zhang *et al*., 2008; Ouyang and Wang, 2006; Fen *et al*., 2010; Yang, 2008; Wa, 2008).

It's of high significance to select the excellent forages available in Karst rocky desertification area and study its interaction with Karst ecosystems. Due to the closely relation of structural characteristics of plant leaves and photosynthetic characteristics with its surroundings, the different adaptable features and mechanisms on forage grass will be shown (Manes *et al*., 1997; Ueda *et al*., 2000;

Corresponding Author: Kang Ning Xiong, South China Institute of Karst, Guizhou Normal University, 550001 Guiyang, China

Midgley *et al*., 2004; John *et al*., 2007). The interaction mechanism between the plants and environmental factors as well as the adaptation to the habitat can be indicated by the relation between photosynthetic characteristics and leaf traits of plants (Guo *et al*., 2002; Cao *et al*., 2007). When the artificial vegetation restoration is done in Karst areas, the assessment of photosynthesis, transpiration and other ecological and physiological characteristics from the selected plant species and understanding their ecological adaptability both can provide the theory basis for the evapotranspiration of plant communities, the research on water balance of ecosystems and production practice in the process of vegetation restoration of degraded Karst ecosystems (Huang *et al*., 2006). The number of study on forage photosynthetic characteristics in Loess Plateau, desert and Northern grassland from domestic academics is big, however, it's small on the Karst rocky desertification area (Xie *et al*., 2004; Deng *et al*., 2003; Yan, 1994; Wang and Zhou, 2000; Huang *et al*., 2001; Xu *et al*., 2007). In this study by studying the physiological and ecological characteristics and the adaptability to the environment of 4 species of forage grasses in Karst rocky desertification habitats, the study result can be regarded as the scientific guidance to develop and utilize forage grasses, make full use of heat and water resources and establish suitable agricultural grass, grass intercropping rotation mode in Karst areas. It's scientifically significative to promote the ecological control and recovery in the rocky desertification areas and establish the sustainable, stable and efficient agriculture and animal husbandry system.

MATERIALS AND METHODS

Natural conditions of study area: Bijie Salaxi Karst rocky desertification control demonstration area of Guizhou Normal University, E 105°4', N 27°2' is typical light-moderate rocky desertification area with an average elevation of 1600 m and the outcropping of limestone. The landform is mountain plateau with serious soil and water loss. The main soil type is yellow soil. Due to various landform types and broken terrain, most of the cultivated lands lie on slopes, platform and in mountain valleys, forming the terraced fields surrounded by mountains and valleys dam fields. The soil is thin with low fertility. It's subtropical monsoon humid climate without cold Winter and hot Summer. The dry and humid seasons are clear. In winter and Spring, it's drought period in Summer, waterlogging period. All year round it's misty. The annual average temperature is about 12°C and the frost-free period is 245 days with 1360 h of the annual average sunshine hours and 984.4 mm of the annual average rainfall. In the watershed, the rainy weather is more with less sunshine and heat. The seasonal rainfall distribution is not uniform and >80% of rainfall is from June to September. What's more, most of the rainfall permeates into the ground by rock gap so, the drinking water and agricultural water are less and difficult to get.

Experiment materials and study methods: On sunny days, September 20, 2013, the research was conducted in Bijie Salaxi Karst rocky desertification control demonstration area of Guizhou Normal University. The experiment materials were *Bromus cartharticus* Vahl, *Festuca elatal* Keng ex E. *Dactylis glomerata* L. and perennial *Lolium perenne* L. In winter of 2012, soil preparations were done. On April 15th, the sowing was begun. The row spacing of Bromus cartharticus was 30 cm and the seeds were sown broadcast in strip. The seeding rate was 1.75 kg/667 m^2; the row spacing of *Festuca elatal* was 30 cm and the seeds were sown broadcast in strip. The seeding rate was 2 kg/667 m^2; the row spacing of *Dactylis glomerata* was also 30 cm and the seeds were sown broadcast in strip. The seeding rate was 2 kg/667 m^2; the row spacing of perennial *Lolium perenne* was 30 cm and the seeds were sown broadcast in strip. The seeding rate was 2.0 kg/667 m^2. After sowing, according to the fertilizer application rate of 30 kg/667 m^2, the Potassium sulfate compound fertilizer was applied into the experiment area, containing 14% nitrogen, 20% phosphorus and 11% potassium. About 7 days after sowing, the seedlings came out. The photosynthetic test was conducted on sunny days, September 20, 2013 from 7:00-19:00 o'clock. It was tested once every 2 h. Researchers chose the middle time to test (8:00, 10:00, 12:00, 14:00, 16:00, 18:00, 6 times in total). Researchers also chose 3 randomly in each species, selecting the unfolding leaves with good growth status in the direction of the sun. Then, researchers made sure of the third to fifth mature leaves from the top, repeating 10 times. Because researchers couldn't test 4 species of forage grasses at the same time, researchers tested in turn. Firstly, researchers tested in order of *Bromus cartharticus*→*Festuca elatal*→*Dactylis glomerata*→perennial *Lolium perenne*; secondly, researchers tested in the reverse order; thirdly, researchers tested again in the order at first time and so on to eliminate the time error during the test. Researchers used the portable photosynthetic measuring instrument (Lcpro +) made by ADC Bio scientific company in UK, setting the red and blue light source leaf chamber to test the instantaneous photosynthetic rate of leaves. The main test indexes include: the net photosynthetic rate (A), transpiration rate (E), CO_2 stomatal conductance (Gs), intercellular CO_2 (CI), leaf temperature (Tleaf), PAR (Qleaf) atmospheric Pressure (P). The data of photosynthetic apparatus are gotten from the SD memory card. Researchers use SPSS20.0 and Microsoft Excel 2007 to read data and conduct statistical analysis. The equation of the instantaneous water use efficiency is:

$$WUE = \frac{Ax}{Ex}$$

Where:
Ax = Net photosynthetic rate
Ex = Transpiration rate

RESULTS

Daily change of main atmospheric factors: The main environmental parameters in experiment site changed as follows: the average temperature of air was 22.32°C at 8:00, rapidly rising to 37.08°C at 10:00, 39.45°C at 12:00, at 14:00 reaching maximum 40.10°C in a day and then slowing down to 35.88 at 16:00°C, at 18:00 decreasing to 24.86°C; the mean of environmental atmospheric pressure is 822.00 mBar at 8:00, slowly rising to 824.89 mBar at 10:00, at 12:00 reaching the maximum 250.00 mBar in a day, 823.00 mBar at 14:00 and then slowing down to 822.21 mBar at 16:00, the minimum 821.05 mBar at 18:00 in a day; the Qleaf mean was 164.18 (mol/(m^2 sec) at 8:00 and then rapidly rose to 1790.83 (μ mol/ m^2 sec) at 10:00, reaching the maximum 2030.40 (μ mol/(m^2 sec) in a day at 12:00, 1687.70 (μ mol/(m^2 sec) at 14:00, rapidly declining to 1687.70 (μ mol/(m^2 sec) at 16:00, reaching the minimum 88.65/μ mol/(m^2 sec) in the day at 18:00. Table 1 is the mean and standard deviation of the environmental parameters in Salaxi experimental site of Bijie City and Table 2 is the daily mean of 3 species of test forage grasses: A, E, WUE, GS and CI.

The diurnal change process of net photosynthetic rate: From Fig. 1 (The daily dynamic change on net photosynthetic rate of 4 experimental forage grasses), researchers can know that the diurnal change curves on net photosynthesis rate of 4 forage grasses can be divided into two types of single peak and double peak judging from the peak shape. *Festuca elatal* is single peak type without obvious midday depression of photosynthesis. At 8:00 the net photosynthetic rate is the lowest in a day then climbs straight up, reaching the peak value at 10:00. Then, it decreases gradually; *Bromus catharticus*, *Dactylis glomerata* and perennial *Lolium perenne* belong to double peak type with the phenomenon of midday depression of photosynthesis but the specific photosynthetic curve is still different. The net photosynthesis rate curve of Bromus catharticus reaches peak value at 10:00. At 12:00, the net photosynthetic rate becomes low and the midday depression of photosynthesis is put off. The valley value appears at 14:00 and the secondary peak value appears at 16:00; the photosynthetic rate of *Dactylis glomerata* reaches peak value at 10:00. At 12:00 the midday depression of photosynthesis phenomenon and valley value appear and the secondary peak value appears at 14:00. The net photosynthetic rate of perennial *Lolium perenne* researches the peak value at 10:00 and the valley

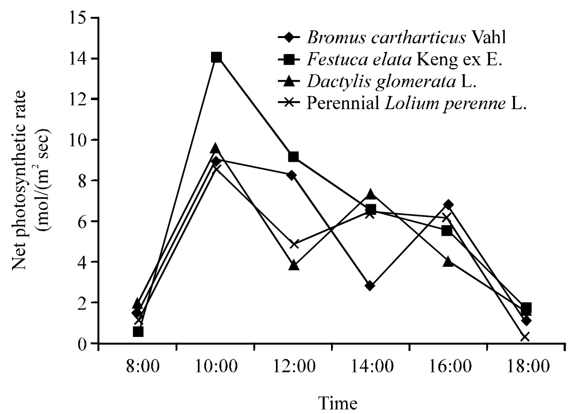

Fig. 1: The daily dynamic change on net photosynthetic rate of 4 experimental forage grasses

Table 1: The mean and standard deviation of environment parameter

Environmental parameter	Average (±standard deviation)
Average photosynthetic active radiation (μmol/(m^2 sec))	1222.37±901.75
Maximum Photosynthetic Active Radiation (PAR) (μmol/(m^2 sec))	2115.6
Air temperature (°C)	33.28±(7.22)
Maximum air temperature (°C)	40.53
Average atmospheric pressure (mBar)	823.03±(1.51)
Maximum atmospheric pressure (mBar)	825

Table 2: The daily mean of A, E, WUE, GS and CI of 4 experimental herbages (average mean±standard deviation)

Forage species	Net photosynthetic rrate (μmol/(m^2 sec))	Transpiration rate (mol/(m^2 sec))	Water use efficiency (μmoL moL^{-1})	Stomatal conductance (μmoL CO_2/(m^2 sec))	Intercellular CO_2 concentration (vmp)
Bromus carthacticus Vahl.	4.87±3.55	4.29±1.90	1.01±0.45	0.22±0.18	275.39±54.79
Festuca elata Keng ex E.	6.23±4.99	5.44±2.38	0.98±0.54	0.35±0.41	276.07±52.60
Dactylis glomerata L.	4.71±3.12	4.42±2.05	0.99±0.26	0.18±0.13	278.89±62.18
Perennial lolium perenne L.	4.53±3.24	4.83±2.16	0.79±0.44	0.22±0.24	276.25±55.70

value of the midday depression of photosynthesis appears at 12:00. The secondary peak value appears at 14:00. The net photosynthetic rates of 4 forage grass species rank: *Festuca elatal*>*Bromus catharticus*> *Dactylis glomerata*>perennial *Lolium perenne*.

The diurnal change process of transpiration rate: From Fig. 2 (The daily dynamic change on transpiration rate of 4 experimental forage grasses) researchers can find that the diurnal variation curves on transpiration rate of 4 species of forage grasses show two trends of single peak and double peak. *Bromus cartharticus* and *Dactylis glomerata* belong to double peak type and the valley value of evaporation rate emerges, respectively at 12:00 and 14:00. At 10:00, the maximum value on evaporation rate of *Festuca elatal*, *Dactylis glomerata* and perennial *Lolium perenne* appears and the maximum evaporation rate of *Bromus cartharticus* happens at 12:00. The evaporation rate of *Bromus cartharticus*, *Dactylis glomerata* and *perennial Lolium perenne*, ranges within 5(mol/(m^2 sec)) and the daily average evaporation rate of only *Festuca elatal* is >5 (mol/(m^2 sec)). The daily average evaporation rates of 4 species of forage grasses rank: *Festuca elatal*>perennial *Lolium perenne*>*Dactylis glomerata*>*Bromus cartharticus*.

The diurnal change process of water use efficiency: Water Use Efficiency (WUE) refers to the amount of plant consumption per unit water production assimilation amount of substance (Xu *et al*., 2007). In this study, researchers use the instantaneous water use efficiency, namely the ratio of net photosynthetic rate and transpiration rate which is calculated by formola 4. There is big difference about the water use efficiency curves of 4 forage grasses (Fig. 3). The daily dynamic change on water use efficiency of 4 experimental forage grasses). At 8:00, the water use efficiency curves of *Bromus cartharticus* and *Dactylis glomerata* roughly are the same, significantly higher than that of *Festuca elatal* and perennial *Lolium perenne*. The water use efficiency of *Festuca elatal* increases fastest at 8:00~10:00, reaching the maximum at 12:00. The water use efficiency of *Dactylis glomerata* increases slowest. The water use efficiency of *Dactylis glomerata* and perennial *Lolium perenne* roughly are the same. After 10:00, the water use efficiency of 4 species of forage grasses shows downtrend, reaching the valley value at 12:00 about the water use efficiency of *Dactylis glomerata* and perennial *Lolium perenne* and then slowly rising. The water use efficiency of *Dactylis glomerata* reaches the maximum at 14:00 and that of *Bromus cartharticus* reaches the secondary peak value at 16:00. The daily average water use efficiency of 4 forage grasses ranks: *Festuca elatal*>*Bromus cartharticus*>*Dactylis glomerata*>perennial *Lolium perenne*.

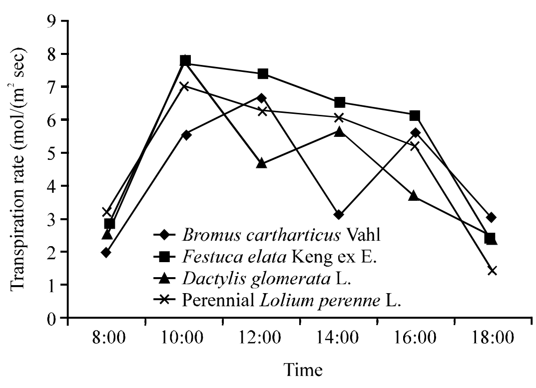

Fig. 2: The daily dynamic change on transpiration rate of 4 experimental forage grasses

The diurnal change process of stomatal conductance: From the diurnal variation curve of stomatal conductance (Fig. 4, The daily dynamic change on stomatal conductance of 4 experimental forage grasses), the

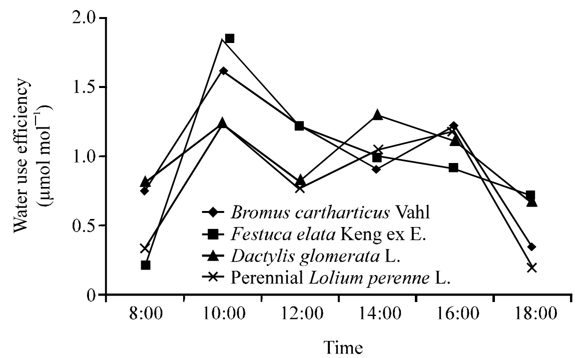

Fig. 3: The daily dynamic change on water use efficiency of 4 experimental forage grasses

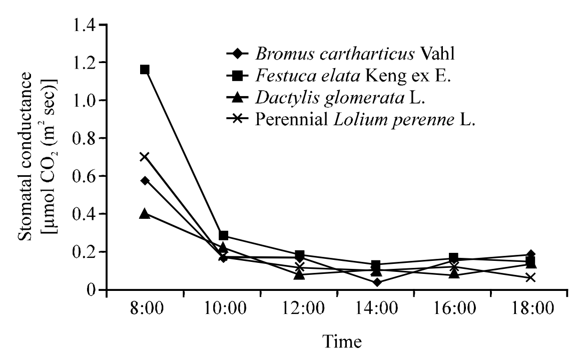

Fig. 4: The daily dynamic change on stomatal conductance of 4 experimental forage grasses

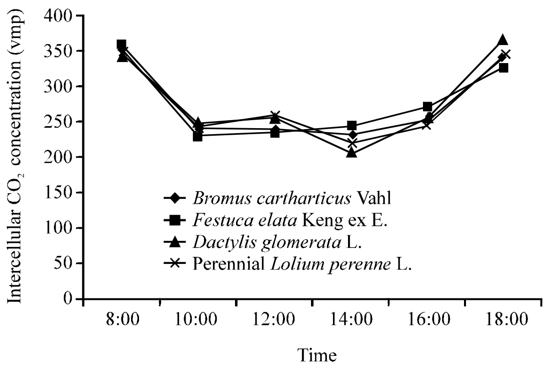

Fig. 5: The daily dynamic change on intercellular CO_2 concentration of 4 experimental forage grasses

maximum value about stomatal conductance of 4 species of forage grasses appears at 8:00, from 8:00-10:00 decreasing rapidly, especially *Festuca elatal* decreasing fastest. After 10:00, the curves on stomatal conductance of 4 species of forage grasses change slowly and relatively stable without obvious valley and peak value. The daily average value on stomatal conductance of *Festuca elatal* is higher than that of the other 3 species of forage grasses and the smallest daily average value of stomatal conductance is *Dactylis glomerata*. The daily average stomatal conductance of 4 species of forage grasses rank: *Festuca elatal*>*Bromus cartharticus*>perennial *Lolium perenne*>*Dactylis glomerata*.

The diurnal change process of intercellular CO_2 concentration: The daily dynamic change curve about intercellular CO_2 concentration of 4 species of forage grasses roughly are the same (Fig. 5, the daily dynamic change on intercellular CO_2 concentration of 4 experimental forage grasses) and the intercellular CO_2 concentration value is high at 8:00, decreasing rapidly from 8:00-10:00. However, the intercellular CO_2 concentration of *Festuca elatal* rises slowly after 10:00. The intercellular CO_2 concentration curves of *Bromus cartharticus*, perennial *Lolium perenne* and *Dactylis glomerata* are basically the same, reaching a small peak value at 12:00, valley value at 14:00 and then increasing slowly. The daily average values on intercellular CO_2 concentration of 4 species of forage grasses rank: *Dactylis glomerata*>perennial *Lolium perenne*>*Festuca elatal*>*Bromus catharticus*.

DISCUSSION

The net photosynthetic rate of *Festuca elatal* is a typical single peak type. Due to the strong light and low temperature in the morning, the net photosynthetic rate is also very low. Because of the continuously strong photosynthetic active radiation at noon and the increasing temperature and light intensity as well as the opening stoma, the net photosynthetic rate also increases, reaching the peak value at 10:00. The net photosynthetic rate of *Festuca elatal* is higher than that of the other 3 grass species at 12:00 indicating that the suffertibility of *Festuca elatal* on high photosynthetic effective radiation and high temperature is stronger than the other 3 species of forage grasses and the sensitive index on midday photosynthetic active radiation and leaf temperature change is low which also benefit from their developed root system. It's the most heat-resistant grass species in cold season grasses with developed roots and strong ability of drought and illness-resistance and good environmental adaptability (He *et al*., 2001). The diurnal change curves on net photosynthetic rate of *Bromus cartharticus*, *Dactylis glomerata* and perennial *Lolium perenne* show double peak type indicating that they are sensitive to the midday photosynthetic active radiation and leaf temperature change, showing the midday depression of photosynthesis at noon, causing low photosynthetic yield and the big difference on daily net photosynthetic rate. The high average daily photosynthetic effective radiation and temperature maybe are the main reasons for midday depression of photosynthesis of 3 grass species. Some studies have shown that the drought-resistance of *Dactylis glomerata* is good, adapting to the arid climate better than cold season grasses (Christie and McElory, 1995; Jensen *et al*., 2003). The midday depression of photosynthesis of Flat ear Brome is put off, probably because the plant's suffertibility on high photosynthetic effective radiation is delayed and it's more sensitive to photosynthetic active radiation than high temperature. The daily average stomatal conductance of *Festuca elatal* is higher than the other 3 forage grass species which is also the main reason for both of its photosynthetic rate and transpiration rate higher than the other 3 forage grasses. As was monitored by Xie *et al.* (2004) in the Loess Plateau regardless of florescence and regeneration stage, the daily average stomatal conductance of *Onobrychis pulchella* and *Astragalus adsurgens* are higher than that of *Galega officinalis* and *Lathyrus odoratus*.

In the whole, *Festuca elatal* is the most heat-resistant grass species in cold season grasses with developed root system (He *et al*., 2001), the net photosynthetic rate of which is significantly higher than that of *Bromus cartharticus*, *Dactylis glomerata* and perennial *Lolium perenne*. Except *Festuca elatal* there is obvious midday depression of photosynthesis about the diurnal variation curves on net photosynthetic rate of the other 3 species of forage grasses, because of strong solar radiation, the low environmental relative humidity and carbon dioxide content, resulting in the inhibition of plant photosynthesis (Hodges, 1967). In this experiment except *Festuca elatal*, the midday depression of photosynthesis phenomena of *Bromus cartharticus*, *Dactylis glomerata* and perennial *Lolium perenne* all emerge but some is typical and some is atypical. The reason probably is that the instantaneous net photosynthetic rate of communities is the goal of the experiment, keeping a balance about the difference of instantaneous net photosynthetic rate between different individual grass and in different positions of forage grasses thereby reducing the effect of adverse environmental factors on the whole community photosynthesis at noon (Ding *et al*., 2006). Water use efficiency is helpful for the high yield of plants under the conditions of lacking water so, selecting the forage grasses with high water use efficiency has become an important physiological index of drought-resistance and breeding of forage grasses (Li, 1997; Johnson, 1993). The roots of 4 experimental forage grasses are developed to make use of the water in deep soil and rocks, forming a good adaptability to arid climatic conditions and the water use efficiency is relatively high.

The water use efficiency of forage grasses depends on CO_2, net assimilation efficiency and transpiration efficiency, affected by the tissue structure characteristics of plant's roots, stems, leaves, also closely related to the environmental factors of light intensity, air and leaf temperature, humidity, air pressure, stomatal conductance, soil moisture and so on (Wen *et al*., 2000). As far as water use efficiency there is some big difference about the diurnal change curves between the water use efficiency of *Dactylis glomerata* in this study and that studied by Ding *et al*. (2006) in Beijing. The main reasons are the geographical environment background difference of experimental sites (subtropical Karst landform and temperate plain) and the different time of measurement. The diurnal variation difference on transpiration rate of different forage grasses in the same period and the same forage grass in different periods is determined by different physiological characteristics, pore structural features and its growth regulars (Xie *et al*., 2004). In the experimental site, except that the water use efficiency curve of *Festuca elatal* is L type, the other diurnal change curves on water use efficiency of *Bromus cartharticus*, *Dactylis glomerata* and perennial *Lolium perenne* basically are M type and water use efficiency changes greatly in a day. The experimental site is on Karst mountain top with arid conditions and water deficit. Fitter and Hay (1981), believes that drought can promote the water use efficiency of plants.

The stomatal conductance (Gs) is one of the important factors about the cycling and balance of plants, water and CO_2 in atmosphere and energy (Yang *et al*., 2013). The plants control the exchange with the outside CO_2 and water vapor and adjust the photosynthetic rate and transpiration rate to adapt to different environmental conditions, especially the soil water provision and air humidity degree by changing the open size of stomata (Yan, 1994). When the stomatal conductance decreases or closes, it can reduce the water transpiration directly. So, almost all the mesophyte and xerophytic plants can adapt to the soil environment of water loss due to midday leaf excessive transpiration or low water level by closing stomata (Xie *et al*., 2004). There are so many studies about the daily change law on stomatal conductance of grasses but the general law is not obvious. In the experimental site, the daily change curves on stomatal conductance of *Bromus cartharticus*, *Festuca elatal*, *Dactylis glomerata* and perennial *Lolium perenne* basically are L type. The stomatal conductance is higher at 8:00~10:00 and it decreases slowly after 10:00. The overall trend is steady. The daily change on stomatal conductance of 4 species of forage grasses indicates that the stomatal conductance is very sensitive to the change of environment factors. All the factors affecting plant's photosynthesis and water status of leaves are likely to influence stomatal conductance (Wang and Zhou, 2000; Sharkey, 1988).

The change of intercellular CO_2 concentration is the basis of analyzing plant's stomatal and non stomatal limitation. As the intermediary of CO_2 in plants' photosynthesis, the intercellular CO_2 concentration, on one hand is affected by external CO_2 concentration and stomatal conductance; on the other hand, it's also influenced by the leaf photosynthetic consumption (Fu and Wang, 1994). For 4 species of forage grasses because the atmospheric CO_2 concentration at 8:00~10:00 doesn't reach the saturation point of CO_2 concentration of grass cells, the grasses will improve the net photosynthetic rate during this period. After the forage grasses reaching the maximum of intercellular CO_2 concentration, the phenomenon of midday depression of photosynthesis will occur.

The natural features of southwest China Karst region are as follows: frail ecosystems, thin soil, low rate of soil formation, bare rocks, quick evaporation of surface water, the easy seepage of rainfall along the corrosion fissures and estavelle, low soil moisture content in Karst soil, serious soil erosion, uneven distribution of precipitation. The implementation of intercropping and rotation between agricultural grass and forest grass can make full use of the limited light, heat, water resources in Karst area, changing the planting mode of crops which makes unary system into polycomponent system and increases the organic features of biodiversity and ecosystems. Therefore, like the leguminous forage, the development and utilization of forage grasses in Karst rocky desertification area is the focused problem of studying Karst grassland agricultural system. *Festuca elatal* belongs to the type of high photosynthesis and high transpiration and it demands more water relatively. However, *Bromus cartharticus*, *Dactylis glomerata* and perennial *Dactylis glomerata* belong to the type of low photosynthetsis and low transpiration and they show high water use efficiency in arid Karst rocky desertification area lack of water.

CONCLUSION

When planting artificial forage grass in Karst rocky desertification area, researchers should consider the net photosynthetic rate, transpiration rate and water use efficiency of forage grasses and adopt different herbage allocation measures not only reducing the transpiration rate and water loss, also increasing water use efficiency and easing the situation of drought and water shortage in rocky desertification area. Both of changing the current planting situation of single sowing grass and conducting the mixture sowing between leguminous forage and herbage with high and low photosynthetic rate and transpiration rate are helpful for the diversity of biological populations in Karst rocky desertification area and improving the production potential of herbage. There are good development future and the value of wide promotion in rocky desertification area.

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