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Studies on Photosynthetic Characteristics of Cardamine Growing in Different Site Conditions in the High Selenium Area in Yutangba

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Abstract

Studying the selenium-enriched plants Cardamine grow in Yutangba, compered their photosynthetic characteristics in four different site conditions (hillsides, selenium slag, streamsides and streams). The results show that the net photosynthetic rate, transpiration rate, stomatal conductance of Cardamine showed a single peak curve. The Cardamine grow in the streamsides and streams have higher photosynthetic ability than the Cardamine grow in hillside and selenium slag. It may be because the selenium concentrations in soil moisture and suitable for the growth of Cardamine.

Mathematics Subject Classification : 92C20, 92B05

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1 Introduction

Cardamine, the Cruciferae Cardamine plant, as 1-2 years herbs. The whole plant for wild edible, medicinal dispersing heat, diuretic and detoxifying, can cure dysentery enteritis, chyluria and various bleeding [1]. Its seed can be extracted oil, oil content 25%. Cardamine as a “drug Edible” wild plant resources with large reserves, has broad development prospect.

Selenium is one of essential trace elements, with its ability to antioxidant regulate immune function and prevention of cancer. Its global geographic distribution is very uneven, few areas due to high levels of selenium in soil or water, leads to selenium poisoning plants and animals; on the other hand, the world and nearly 2/3 of the region lack of selenium, so the use of selenium high-Se plants and finding the ideal biological treatment of selenium poisoning germplasm become a research hotspot. The Cardamine grows in Enshi Yutangba area has a strong capability in enriching the selenium content from environment, and identified as a new germplasm [2]. Therefore, studying the photosynthetic characteristics of Cardamine growing in different site conditions, different concentrations of selenium in their photosynthesis is the basis for exploring its physiological selenium work.

2 Materials

2.1 Research areas overview and experimental material

Yutangba located in the north of Enshi Shuanghe township, is a closed a small basin of strip near the southwest to the northeast, Longitude $30^{\circ}32'$, latitude $109^{\circ}60'$, about 1400 ~ 1500m above sea level, between average annual temperature is $19^{\circ}C$, annual precipitation is about 1400mm, frost-free period 210d, soil $pH6.4 \pm 0.3$, the soil background selenium concentrations 43.52mg/kg, water-soluble selenium-containing 3.816mg/kg. Produce a large number of selenium minerals, constitute the world's very rare deposition of selenium deposits [3], and so far the only selenium poisoning outbreak occurred in the crowd of popular areas [4].

Cardamine grows well in Yutangba, showed plexiform distribution group, an area of about 0.03km^2 . In this study, the different site conditions in accordance with established four zones, namely hillsides, selenium slag, streamsides and streams (the selenium concentrations were elevated), selenium ore as the starting point every 100m to take five samples in parallel, each sample side of each site selected five research material conditions.

2.2 Methods

2.2.1 Determination of growth parameters

Wash samples with distilled water, dry gauze moisture, measured plant height and root length, weigh fresh weight. Then, 105°C in the oven for 15 minutes fixing, 80°C constant temperature drying for 24 hours, the sample was dried, and weigh dry weight, get multiple sets of data.

2.2.2 Determination of chlorophyll content

Using spectral absorption method [5] to get multiple sets of data.

2.2.3 Determination of soluble sugar content

Using anthracene ketone colorimetric method [5] to get multiple sets of data.

2.2.4 Determination of diurnal variation of photosynthesis

Cardamine generally begin flowering in mid-April, around the fruit ripening in June, Plants grow the fastest during the period of bud (In early May). This study choose sunny weather in the morning 10:10-14:10, with the TPS-1 portable photosynthesis system, measured once per hour, the net photosynthetic rate (P_n), stomatal conductance (G_s), transpiration rate (Tr), intercellular CO_2 concentration (C_{Int}) parameters, and water use efficiency calculated according to the formula ($\text{WUE} = P_n / Tr$). When measured in natural light as the light source, select the robust plants, parts of the same sunny growing plants to start the first two leaves of in vivo measurement, data averaging.

2.2.5 Data Analysis

Using SigmaPlot 10.0 software for data mean, standard deviation analysis and graphics.

3 Results and Analysis

3.1 Compare growth parameters under different site conditions

Root length, plant height, wet and dry weight can be more intuitive situation and reflects the growth of plants, from the photosynthetic characteristics of the macro as a basis of fundamental analysis. Figure 1 shows the Cardamine growing in different site conditions are significant differences in root length and plant height.

In Different site conditions, the Cardamine grow in hillside and the stream-sides fresh weight, dry weight are significantly higher than the other two regions, this is similar to the results of Peng Cheng [6]. Whether it is the root length, plant height or fresh weight, dry weight, the Cardamine growth in the streamsides is much higher than the other, possibly because of the impact of selenium, and semi-dry environment is more appropriate for the growth of broken chestnut.

3.2 Compare chlorophyll content under different site conditions

As can be seen from Figure 2, in different site conditions the chlorophyll content of Cardamine have some differences the Cardamine grow in the selenium slag, streamsides leaf chlorophyll a and chlorophyll b content higher than other areas, which may be because the amount of selenium can promote increased chlorophyll content [7]. Chlorophyll content is conducive to plant absorption and utilization of light energy, and thus result in higher photosynthetic capacity.

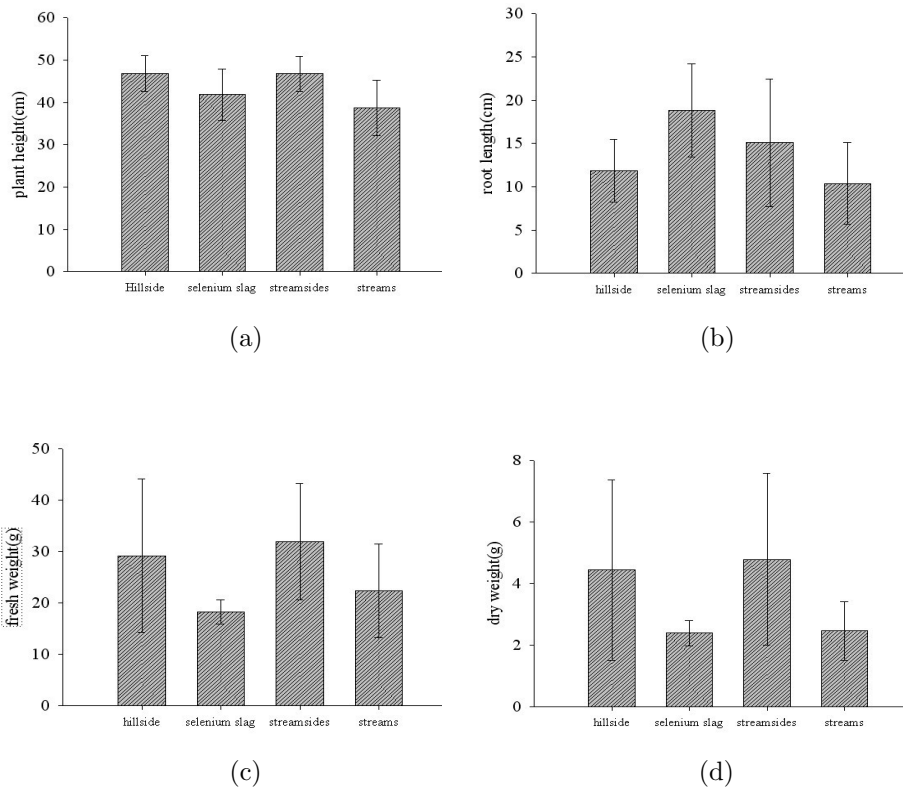


Figure 1: Comparison of root length, height, fresh weight, dry weight of Cardamine in different site conditions

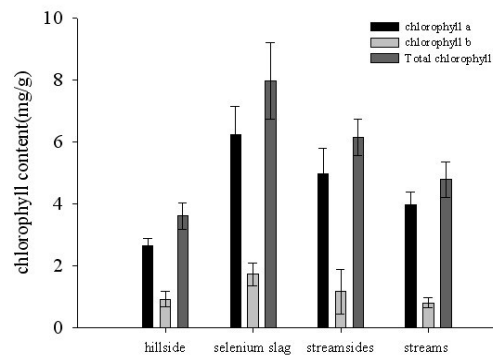


Figure 2: Comparison of chlorophyll content of Cardamine in different site conditions

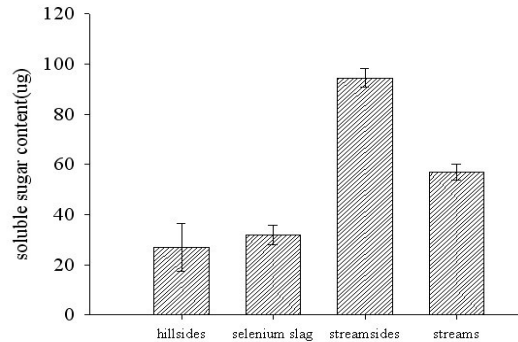


Figure 3: Comparison of soluble sugar content of Cardamine in different site conditions

3.3 Compare soluble sugar content under different site conditions

Soluble sugar is the main soluble plant nutrients, also an important parameter of its physiological activity. It can be seen from Figure 3, in different site conditions the Cardamine grow in the streamsides and streams leaf soluble sugar content are higher than other areas, which may be because the selenium concentrations in soil moisture and suitable for the growth of Cardamine.

3.4 Compare diurnal variation of photosynthesis under different site conditions

It can be seen from Figure 4, under different site conditions, net photosynthetic rate of Cardamine showed a single peak curve, there is no significant “lunch break” phenomenon. Around 11:10 in the morning, the net photosynthetic rate of leaves is the highest, indicating an increase of light intensity on the morning more sensitive, make full use of favorable conditions for the morning, then as light intensity increases, higher temperatures, photosynthetic rates began to appear flat decline.

The stomatal conductance and net photosynthetic rate variation are consistent (Figure 4). Net photosynthetic rate down contain stomatal limitation or non-stomatal limitation [8]. Generally with the intercellular CO_2 concentration and stomatal conductance changes in direction and standards as a basis for discrimination: When the net photosynthetic rate and stomatal conductance

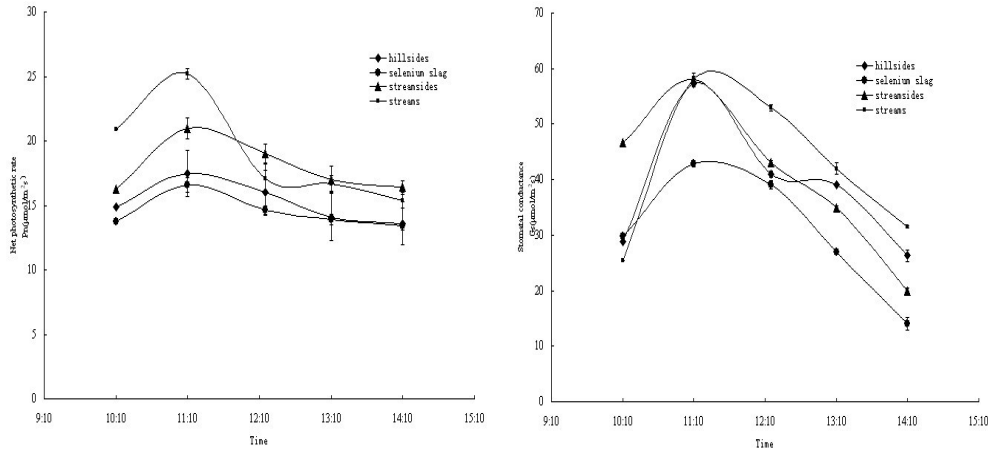


Figure 4: Diurnal changes of net photosynthetic rate and Stomatal conductance of Cardamine in different site conditions

decreased, if the intercellular CO_2 concentration decreased, it was stomatal limitation; on the contrary, it was non-stomatal limitation. In this study, with the reduction of net photosynthetic rate, and the CO_2 concentration increased of mesophyll cells shows lower photosynthetic rate is reducing the stomatal conductance.

Under different site conditions, the intercellular CO_2 concentration changes is opposite to net photosynthetic rate (Figure 5). This is because when the plant net photosynthetic rate is high, the leaves of CO_2 fixed up, so the decline in intercellular CO_2 concentration; However, with the light intensity gradually weakened, gradually reduce the net photosynthetic rate, leaf to enhance the ability of photorespiration, intercellular CO_2 concentration then a slow recovery.

Transpiration is an important physiological metabolic to water metabolism of plant. Leaf transpiration depends on the strength of both stomatal conductance (Gs), but also on the leaves inside and outside the vapor pressure deficit (VPD). It can be seen from Figure 5, the transpiration rate showed a single peak diurnal variation, and the peaks are seen in around 12 noon, this may be because around 12 noon is the maximum photosynthetic active radiation, the highest temperature time, the fastest time of the plant water loss and leaf temperature increased rapidly, causing the leaves inside and outside the cell vapor pressure increases, the transpiration rate faster. In the anatomical study

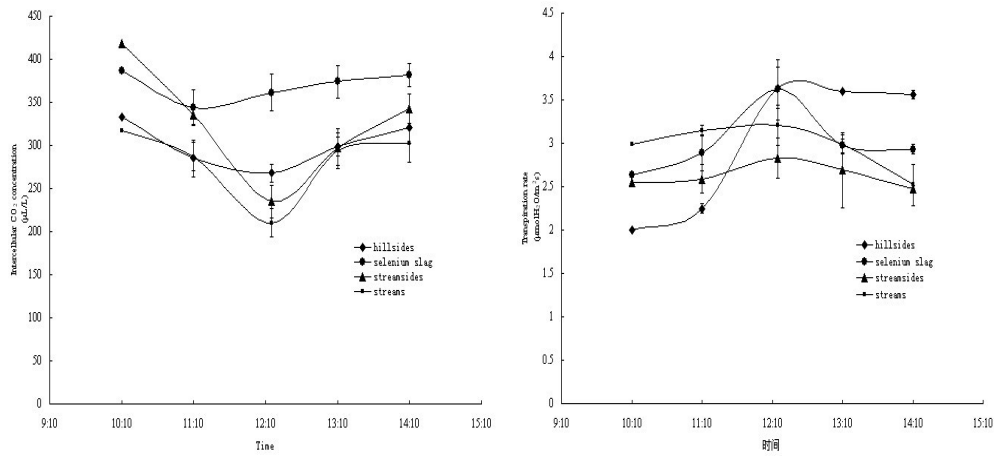


Figure 5: Diurnal changes of intercellular CO₂ concentration and transpiration rate of Cardamine in different site conditions

of Cardamine, we found well-developed vascular tissue and dense leaf stomata to take part in transpiration, and thus increase the absorption of selenium.

Water use efficiency reflects the level of water use, can comprehensive evaluate plants photosynthesis and transpiration. It can be seen from Figure 6, with the light intensity increases, the increase of stomatal conductance, net photosynthetic rate of plants gradually increased, then the relative humidity in the air, the transpiration rate is more appropriate, so at this time the Water use efficiency of Cardamine is higher; by noon, the highest light intensity, temperature rising rapidly, the rapid decline in air relative humidity, stomata partially closed, resulting net photosynthetic rate down, but transpiration rate has remained at a high level, so the water use efficiency slow declining.

From Figure 4, Figure 5 and Figure 6 also show that under different site conditions the Cardamine diurnal variation in photosynthetic parameters are basically the same, the Cardamine growth in the streamsidess and streams has higher net photosynthetic rate and Water use efficiency, but the intercellular CO₂ concentration and transpiration rate is lower, indicating that the two site conditions Cardamine can use more solar energy and water chestnut, to better adapt to the environment.

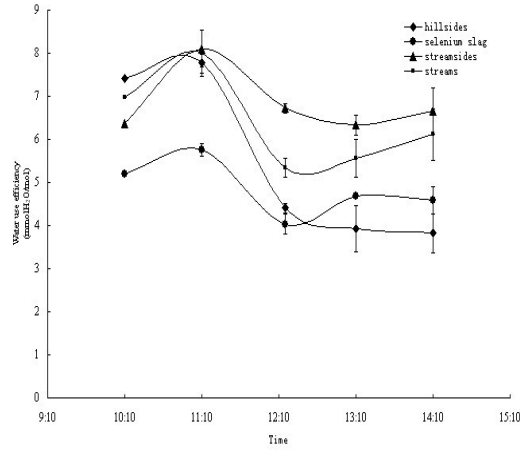


Figure 6: Diurnal changes of Water use efficiency of Cardamine in different site conditions

4 Discussion

1. Compare plant height, root length, fresh weight and dry weight of Cardamine under different site conditions, significant differences are found, which is consistent to the Related research.
2. Study on chlorophyll and soluble sugar content of Cardamine under different site conditions, find the Cardamine grows in the streamsides has higher chlorophyll and soluble sugar content than both the other site conditions, this may be because the soil selenium concentration is moderate stream, moderate humidity, more suitable for the growth of broken chestnut reasons.
3. Under different site conditions, the net photosynthetic rate, transpiration rate, stomatal conductance of Cardamine showed a single peak curve. There are some differences in photosynthetic capacity between them, the Cardamine grow in the streamsides and streams had higher photosynthetic ability than the Cardamine grow in hillside and selenium slag.

The Cardamine growing in Yutangba as Selenium-enriched plants, with good prospects of development and research value, so the analysis of their photosynthetic characteristics of selenium, will help biological function of selenium, benefit human health can also promote the metabolism of plant physiological

research, and service in agricultural production, development and utilization of this resource to provide a theoretical basis.

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