Effect of Stereoscopic Planting on Physiology and Biochemistry of Oil Peony Leaves

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Abstract: In order to investigate the effects of stereoscopic planting of trees and shrubs planting on the physiology and biochemistry of oil peony, the growth indexes of peony leaves used in vertical and non-vertical planting were measured: the leaf width, the leaf length, the crown width and the plant height, chlorophyll content, soluble protein content, soluble sugar content, MDA content, SOD activity, POD activity and CAT activity. The results showed that the stereoscopic planting of oil peony and idesia polycarpa could provide a suitable growing environment for the oil peony, so the stereoscopic planting of trees and shrubs was more suitable for the oil peony.

1 INTRODUCTION

Peony (Paeonia suffruticosa Andr) is a famous, traditional, ornamental and medicinal plant in China, and has strong resistance to adversity and wide ecological adaptability. In recent years, Paeonia rockii and Paeonia ostii among peonies have been listed as woody oil plants, collectively referred to as oil peony, because of their high seed setting rate, rich oil in seeds and good oil quality. According to research, the oil content of peony seed oil is generally 25% to 28%, and the content of unsaturated fatty acids is above 90%, and the content of linolenic acid is above 40%. It is rich in terpenoids, polyphenols and other non-volatile components, and has certain antioxidant, hypoglycemic, lipid-lowering, antibacterial, cardiovascular disease prevention and other effects. Idesia polycarpa var. vestita Diels is a woody oil plant belonging to Idesia in Salicaceae. The fruit is rich in oil, the content of which is up to 40%, and the oil contains more higher fatty acids and polyunsaturated fatty acids, among which linoleic acid is the most abundant, accounting for about 60% of the oil content (Li 2019). Therefore, peony is rapidly developing as an emerging woody oil plant (Feng 2019).

Stereoscopic planting is a comprehensive matching technology that establishes multi-crop symbiosis, multi-level structure and multi-level functional cycle based on the characteristics of natural resources and the characteristics of different crops, with the goal of improving the yield, economic and ecological benefits within a certain production cycle (Gao 2013). Song Huibo et al believe that the choice of the stereoscopic planting of deciduous trees and oil peony is a beneficial way of planting oil peony. Taking Heze City as an example, deciduous trees such as Toona sinensis, walnut and ash that germinate from March to April and grow their leaves in June can be selected (Song 2021). Chen Fazhi et al believe that the stereoscopic planting of autumn frost pear and oil peony can improve land-use efficiency and output. In summer, autumn frost pear trees provide a shady environment for oil peony and prolong the growth cycle of oil peony (Chen 2021). Oil peony is a perennial deciduous, shallow-rooted small shrub, and idesia polycarpa is a deep-rooted tree and lighting-loving tree, with alternate simple leaves and broadly ovate. The leaf blade margin is sparse and shallow crenate, with scattered glands on the petiole, large leaf spacing, good ventilation effect and good light transmission. If stereoscopic planting is carried out, there will not be a great conflict in water and fertilizer utilization, and the oil peony can get proper shade and sufficient light (Hu 2009).

In this experiment, the effects of stereoscopic planting on the physiology and biochemistry of oil peony were studied by using the stereoscopic planting of idesia polycarpa and oil peony as the test materials, and the leaf growth indexes and physiological and

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biochemical indexes of oil peony were measured. The aim is to provide theoretical basis for stereoscopic planting of idesia polycarpa and oil peony.

2 MATERIALS AND METHODS

2.1 Test Base

The experimental site is located in Gaoyan village, Qingping Town, Central District of Leshan City, in the humid subtropical climate zone. It has the characteristics of warm winter and hot summer, four distinct seasons, abundant heat, rain in hot season, moderate rainfall, long frostless period and less sunshine. The annual average temperature is 17.4 ℃, and the extreme minimum temperature is - 4.3 ℃, and the extreme maximum temperature is 38.1 ℃. The annual sunshine duration is 1177.9 h, the average annual frostless period is 339 d, the average annual rainfall is 1386 mm, the average annual relative humidity is 81%, and the average annual total solar radiation is 7.13 kcal / cm^2. The terrain shallow hill with sea level of 359.8-471m, sandy soil and good air permeability.

2.2 Test Materials and Treatment

The test material was 4 a-bearing 'Fengdan ', which belonged to the Jiangnan peony variety group, and is a variety group of medicine oil combination formed by the long-term cultivation evolution of Yangshan peony (Paeonia ostii T.Hong et J.X.Zhang. The plant line spacing was 0.6×0.6 m. The plant line spacing of idesia polycarpa was 3 × 3.5 m. The experiment was conducted on the morning of March 27, 2021. Five oil peonies planted in stereo and non-stereo were selected separately, and their leaf length, leaf width, crown width and plant height were measured with a tape measure, and the average value was recorded. Three functional leaves were also collected, wrapped in tinfoil and brought back to the laboratory for determination.

2.3 Test Method

The chlorophyll content of oil peony leaves was determined by chlorophyll portable meter (SYS-LAM-B). Soluble sugar content was determined by anthrone colorimetry (Li 2012) standard curve was: $y = 0.0147x + 0.2238$, $R^2 = 0.9902$. The soluble protein was stained with Thomas Brilliant Blue G-250 (Lu 2015) and the standard curve was: $y = 0.018x - 0.0127$, $R^2 = 0.9954$. Malondialdehyde content in leaves was determined by thiobarbituric acid (Lu 2015); catalase, superoxide dismutase and peroxidase activities were determined by spectrophotometric method.

2.4 Data Analysis

Data were analyzed significantly using SPSS 19.0 and statistical analysis of data was performed using Excel 2010 software.

3 RESULTS AND ANALYSIS

3.1 Leaf Growth Index of Oil Peony Grown in Stereo

Tab. 1 shows that the leaf length, leaf width, crown width and the plant height of oil peonies planted in stereo with idesia polycarpa were superior to those of non- stereo with oil peonies. The average leaf length, leaf width, crown width and plant height of oil peony planted in stereo were 8 cm, 27 cm, 17 cm and 26 cm larger than those of oil peony planted in monoculture, respectively.

3.2 Leaf Physiological and Biochemical Indexes of Oil Peony Grown in Stereo

Tab. 2 shows that the chlorophyll content, soluble sugar content and soluble protein content of oil peonies leaves grown in stereo with idesia polycarpa were higher than those of planted in non-stereo. Soluble sugar and soluble protein contents of oil peony planted in stereo were 0.24%, 3.8% and 85.76% higher than those of non-stereo planted oil peony.

3.3 Antioxidant Enzyme Activity of Oil Peony Leaves Grown in Stereo

From Tab. 3, it can be seen that the activities of antioxidant enzymes SOD, POD and CAT of oil peony leaves grown in stereotypes of idesia polycarpa and oil peony were higher than those grown in non-stereotypes. The SOD, POD and CAT enzyme activities of the stereocultural oil peony leaves were 71.05 U, 70.6 U and 70.62 $^{A240\text{-}min\text{-}1\text{-}}$ $^{g\text{-}1}$ higher than those of the non-stereocultural ones. However, the content of MDA in the stereocultural oil peony leaves

was significantly lower than that of the non-stereocultural ones by 36.59%.

3.4 Content of MDA of Oil Peony Leaves Grown in Stereo

As shown in Fig. 1, the MDA content of oil peony leaves planted in stereoscopic mode was 0.0123 umol. g^{-1}, and the MDA content of oil peony leaves of non-stereoscopic planting was 0.0168 umol. g^{-1}. The content of MDA in the leaves of oil peony planted in stereoscopic planting was significantly less than 36.59% in non-stereoscopic planting.

4 DICUSSION

Peonies prefer to grow under transparent but not directly shaded and unenclosed forests (Wang, 2018), therefore, stereoscopic planting is beneficial to the development of oil peony industry According to the observation and statistics of phenological period of idesia polycarpa in Leshan area from 2019 to 2021, the spring germination time of idesia polycarpa is early March and the leaf growth time is early April. The germination time of oil peony is at the end of January, and the flowering branches begin to sprout in the middle of February and the flowering begins in the first ten days of March every year. Oil peony and idesia polycarpa are in different rapid growing period. Therefore, when the light is not strong in early spring, sufficient sunlight can percolate through the branches and leaves of idesia polycarpa. The oil peony grows in an environment with sufficient light. When the light is strong in summer, the mature idesia polycarpa leaves can block more sunlight and provide a cool and shady environment for the growth of oil peony, reduce the damage of high temperature and strong light in summer to the leaves of oil peony, can be more beneficial to the growth of oil peony. Planting oil peony between the rows of idesia polycarpa can reduce the growth of weeds, improve soil moisture, change soil environment and regional climate, and is conducive to their growth.

In this study, oil peony under stereoscopic planting showed better growth and development, that is, large leaf length and width, high crown and plant height, and high chlorophyll content of leaves. It was closely related to the stress resistance and adaptability of plants to the environment. High activity of SOD, CAT and POD enzymes play an important role in free radical equilibrium, and the biofilm was damaged, resulting in a better state of slow MDA content (Bai 2017).

5 CONCLUSION

Stereoscopic cultivation is an efficient way to make full use of land, which can change local microclimate and improve soil physicochemical properties (Li 2010, Wang 2015). In the stereoscopic planting of idesia polycarpa and oil peony, a suitable environment for growth of oil peonies is created by making full use of the difference in plant height between idesia polycarpa and oil peony, the phenological period, the combination of deep root system and shallow root system. Therefore, the stereoscopic planting model is a beneficial method for the cultivation of oil peony.

Table 1: Leaf growth index of oil peony grown in stereo.

	Average Blade length/cm	Average Blade width/cm	Crown width/cm	Plant height/cm
Stereotypical planting	87	58	81	98
Non-stereo planting	49	31	64	72

Table 2: Physiological and biochemical indicators of oil peony leaves planting in stereo.

	Chlorophyll content/SPAD	Soluble sugar content/%	Soluble protein content/mg. g^{-1}
Stereotypical planting	31.9	51.19	8.62
Non-stereo planting	31.2	47.39	4.64

Table 3: Antioxidant enzyme activities of oil peony leaves grown in stereo.

	SOD/U	POD/U	CAT/ A240-min^{-1}- g^{-1}
Stereotypical planting	357.89	706.2	706.21
Non-stereo planting	286.84	635.6	635.59

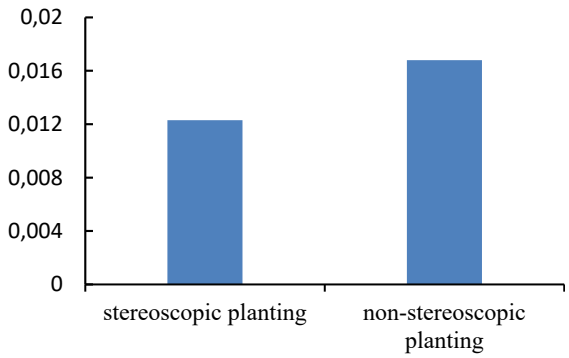

Figure. 1 Content of MDA of oil peony leaves grown in stereo.

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