

Effects of Continuous Shade Stress during Procreation Growth Stage on Isoflavone and Lignin Accumulation in Developing Soybean Seed

Wen-Ting Qin^{a,b,1}, Cai-Qiong Yang^{a,b,1}, Zheng Lei^{a,1}, Wen-yu Yang^{a,*}, Jing Zhang^{a,*}, Jiang Liu^{a,b}

^a Key Laboratory of Crop Ecophysiology and Farming System in Southwest, Ministry of Agriculture, Chengdu 611130, China

^b Institute of Ecological Agriculture, Sichuan Agricultural University, Chengdu 611130, China

* Corresponding author. Tel.: +28 86290960; fax: +28 86290870.

E-mail address: jingzhang@sicau.edu.cn (J. Zhang), mssiyangwy@sicau.edu.cn (W.-Y. Yang).

¹ These authors contributed equally to this work.

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Abstract: A pot experiment was conducted to study the effects of continuous shade stress during procreation growth stage on isoflavone and lignin accumulation in developing soybean seed. The results showed that continuous shade stress during procreation growth stage could improve the isoflavone and lignin accumulation, and seeds at R7 stage accumulated the highest isoflavone concentration (1.96 mg/g) but R8 stage has the highest lignin concentration (7.53%).

Introduction

Soybean (*Glycine max* (L.) Merr.) is the world's most widely grown grain legume[1] and it have become a well-known functional food that provides numerous beneficial secondary metabolites, such as isoflavone and lignin[2]. In addition to being a beneficial food to health, isoflavone and lignin contributed to all aspects of plant responses towards biotic and abiotic stimuli, such as fungal or bacterial infection[3], UV irradiation[4], high temperature stress[5] and water deficits[6]. Soybean is highly sensitive to shading, thus, when grown with shading, soybean seedlings have increased height and thinner stems that are easier to lodge[7]. Previous report also indicated that the shaded treatment had a large increase in glucosides and flavones[8]. But it has not been reported in soybean developing seeds. Therefore, an analysis of the relationships between the light environment and the accumulation characteristics of soybean seeds is important to study the mechanism on

shading in the future. In this study, we used developing seeds for the purpose of screening the influence of shading on isoflavone and lignin accumulation.

Materials and Methods

Materials. The experiments were conducted at Sichuan Agricultural University (30°42'N, 103°51'E), Wenjiang, China. The seeds of soybean named ND12 were cultivated on Sichuan Agricultural University's farm in the ya'an region in 2016. All chemicals used in experiments were of chromatographic grade.

Experimental Design. This study was carried out in the research greenhouse of the Key Laboratory of Crop Ecophysiology of the Sichuan Agricultural University. Plants of the cultivar ND12 were sown into each of a series of plastic pots (25 cm diameter and 22 cm depth) filled with nutritional soil. The cultivar was replicated 5 times for each treatment. Plants were grown with a 12 h photoperiod and temperature held constant at 25°C, relative humidity 60%, carbon dioxide have reached 350PPM. After flowering, shading was added to each pot, marked SD. The PAR of CK was 2000 lux (R/FR=1.15), SD was 850 lux (R/FR=0.35). Pots were watered as needed. Seeds were sampled at the R6, R7 and R8 stage respectively. Upon harvest, seeds were flash frozen with liquid nitrogen and stored at -80°C.

Statistical analyses. Statistical analyses were performed using SPSS 13.0 statistical software (IBM, Chicago, IL, USA). Data were analyzed by one-way ANOVA with least significant difference (LSD) at a 5% confidence level.

Results and Discussion

Isoflavone Concentration

With the development of seeds in the stage of procreation growth, isoflavone concentration increased and then decreased, seeds at R7 stage accumulated the highest (1.96 mg/g) concentration. Compared with CK, continuous shade stress on the stage of procreation growth (marked SD) can significantly increase the isoflavone concentration of soybean seeds in all stage, as well the seed at

R7 stage accumulated the highest (2.38 mg/g) concentration, and the average concentration of isoflavone was therefore approximately 18% higher in SD than in CK.

In addition the difference between R7 and R8 didn't appear obviously on isoflavone concentration under SD ($p>0.05$), which illustrate that the most sensitive stage of shade stress is R7, and the impact on R8 was not obvious.

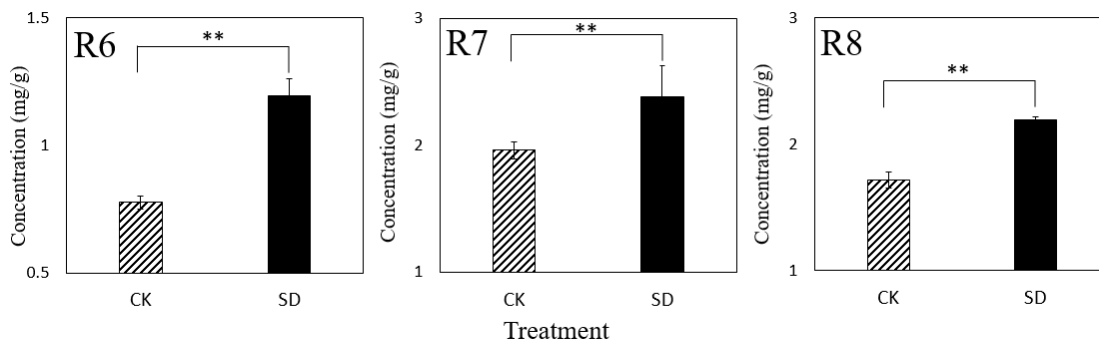


Fig. 1 Effects of continuous shade stress during procreation growth phases on isoflavone concentration of soybean seeds

Lignin Concentration

In the stage of procreation growth, lignin concentration of developing seeds increased, which at R8 stage accumulated the highest (7.53%) concentration. Compared with CK, SD can also significantly increase the lignin concentration of soybean seeds in all stage, seeds at R8 stage accumulated the highest (9.46%) concentration similarly, and the average concentration of lignin was therefore approximately 20% higher in SD than in CK. These results show that the impact of shade stress on lignin in R8 was obvious.

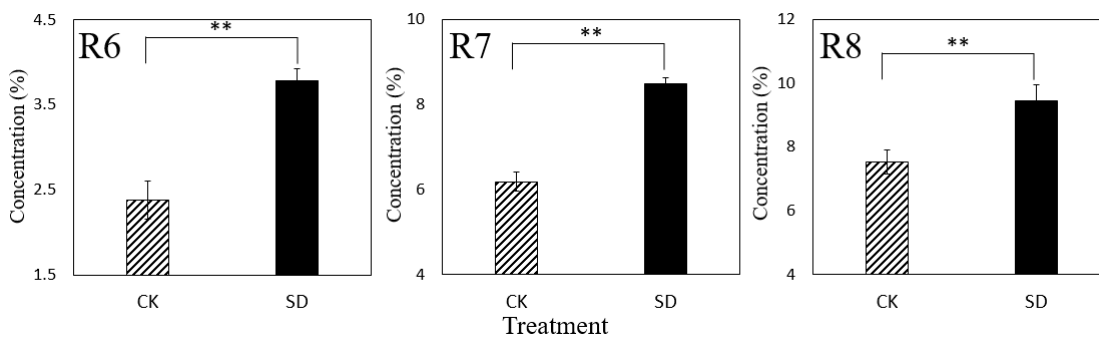


Fig. 2 Effects of continuous shade stress during procreation growth phases on lignin concentration of soybean seeds

Conclusions

When the plant was under stress, isoflavone and lignin can react quickly[9]. Berger et al. also studied isoflavone accumulation in developing seeds are increased[10] and the stress can promoted. The results of this experiment showed that continuous shade stress on the stage of procreation growth could improve isoflavone and lignin concentration of developing soybean seeds, but the highest concentrations of isoflavone and lignin are different. The attempt to further enhance isoflavone and lignin accumulation in soybean reinforced the knowledge on the shade stress, lay the foundation of the shade-tolerance of soybean.

Acknowledgments

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