‘泓森槐’幼苗生理生态特性对模拟氮沉降的响应研究

刘华[1] 张嫚茹[1] 铖[1] 冯嘉鑫[1]

（1. 安徽农业大学林学与园林学院 合肥 230036）

摘 要:【目的】城市大气氮沉降与植物的响应及共存机制在一定程度上反映出城市植物提供生态系统服务的能力。‘泓森槐’刺槐良种是适于城市园林绿化的新品种，具有的无刺、速生、抗性强等特征，探究其应对氮沉降的生理生态特征变化具有一定的现实意义。【方法】通过模拟氮沉降控制试验，以 NH_4NO_3 作为氮源，‘泓森槐’作为氮添加对象，设置了低氮（LN, 5 $g·m^{-2}·a^{-1}$）、中氮（MN, 10 $g·m^{-2}·a^{-1}$）和高氮（HN, 15 $g·m^{-2}·a^{-1}$）3 个模拟氮沉降水平，将每种氮处理的应施氮量平均分成六份，每月月初将不同氮处理所需氮肥制成溶液进行喷施，以清水喷施最为对照。分别于施氮后的 30 d、58 d、89 d、119 d、152 d 和 180 d 测定根系和土壤 TC、TN 和 TP 含量，以及土壤酶活性。【结果】结果表明：（1）模拟氮沉降在一定程度上促进了‘泓森槐’根系的生长，随着施氮时间的延长，促进作用逐渐减弱，甚至抑制生长；（2）氮沉降提高了‘泓森槐’幼苗茎、叶、根的氮（N）、磷（P）含量，降低叶碳（C）含量，LN 处理下茎、根的 C 含量显著增加（$P<0.05$），HN 处理下降低；氮沉降降低了叶与根的 C:N、C:P、N:P 比以及茎的 C:N、C:P；（3）氮沉降提高了根系-土壤养分系统间的协调度，中氮处理不利于根系-土壤养分系统耦合度的提升，根系养分综合评价指数在低氮处理下达到最大值，比对照高出 496.68 %，更有利于根系-土壤养分间的协调发展；（4）氮沉降导致土壤酸化，HN 处理下土壤酸度最大；随着氮浓度增加，土壤中的 C、N、P、微生物生物量碳（MBC）、微生物生物量氮（MBN）含量以及土壤脲酶（Ure）、酸性磷酸酶（Acp）、过氧化氢酶（Cat）活性均先升高后降低；土壤 C、N、P 含量以 MN 处理最高，MBC、MBN、Ure、Acp、Cat 均以 LN 处理下最高；土壤蔗糖酶（Suc）活性持续升高，且 HN 处理下的活性高于 LN 和 MN；氮沉降提高了土壤 C:N、C:P、N:P，降低了 MBC:MBN；土壤 C、N、P、MBC、MBN 含量以及 Ure、Acp、Cat、Suc 活性随着土壤深度的加深而降低；随着施氮时间的延长，土壤 C、P、MBC、MBN 含量分别在 152d、119d、89d、89d 达到最大值。【结论】因此外源氮素输入有利于苗木根系的生长，对‘泓森槐’生产力提高具有促进作用，低氮输入能够更好的维持生态系统的稳定性。此外，在本研究中耦合协调度综合评价指数结果表明根部养分的综合评价指数高于土壤养分，表明在模拟氮沉降环境下‘泓森槐’根系的养分发展要优于土壤养分的发展。

关键词: 氮沉降；根系；土壤；耦合协调度

Study on the Adaptability of Simulated Nitrogen Deposition to *Robinia pseudoacacia* ‘Hongsen’ Seedlings

Abstract:【Objective】The response and coexistence mechanism of urban atmospheric nitrogen deposition and plants reflect the ability of urban plants to provide ecosystem services to a certain extent. The good species of *Robinia pseudoacacia* ‘Hongsen’ is a new variety suitable for urban landscaping, with the characteristics of thornless, fast-growing, and strong resistance, and it is of certain practical significance to explore the physiological and ecological characteristics of nitrogen deposition in response to it.【Method】Through the simulated nitrogen deposition control test, NH_4NO_3 was used as the nitrogen source, and *R. pseudoacacia* 'Hongsen' was used as the nitrogen addition object, and three simulated nitrogen deposition levels of low nitrogen (LN, 5 $g·m^{-2}·a^{-1}$), medium nitrogen (MN, 10 $g·m^{-2}·a^{-1}$) and high nitrogen (HN, 15 $g·m^{-2}·a^{-1}$) were set up, and the nitrogen application amount of each nitrogen treatment was evenly divided into six parts, and the nitrogen fertilizer required for different nitrogen treatment was sprayed as a solution at the beginning of each month, and the clean water spraying was the control

(CK). The TC, TN, and TP contents of roots and soil, and soil enzyme activity were determined at 30 d, 58 d, 89 d, 119 d, 152 d, and 180 d after nitrogen application.【Result】: (1) simulated nitrogen deposition promoted the growth of the root system of *R. pseudoacacia* 'Hongsen' to a certain extent, and with the extension of nitrogen application time, the promotion effect gradually weakened and even inhibited growth; (2) Nitrogen deposition increased the contents of nitrogen (N) and phosphorus (P) in stems, leaves, and roots of *R. pseudoacacia* 'Hongsen', decreased the content of organic carbon (C) in leaves, and significantly increased the C content of stems and roots under LN treatment ($P<0.05$), which decreased under HN treatment. Nitrogen deposition reduced the C: N, C: P, N: P ratio of leaves to roots and C: Nand C: P of stems; (3) Nitrogen deposition improved the coordination degree between root-soil nutrient systems, medium nitrogen treatment was not conducive to the improvement of root-soil nutrient system coupling; and the comprehensive evaluation index of root nutrients reached a maximum value under low nitrogen treatment, which was 496.68% higher than that of the control, which was more conducive to the coordinated development of root-soil nutrients; (4) Nitrogen deposition led to soil acidification, and the soil acidity was the largest under HN treatment; With the increase of nitrogen concentration, the contents of C, N, P, microbial biomass carbon (MBC), microbial biomass nitrogen (MBN) and soil urease (Ure), acid phosphatase (Acp) and catalase (Cat) activities in soil increased first and then decreased. The soil C, N, and P contents were the highest under MN treatment, and MBC, MBN, Ure, App, and Cat were the highest under LN treatment. The activity of soil sucrase (Suc) continued to increase, and the activity under HN treatment was higher than that of LN and MN. Nitrogen deposition increased soil C: N, C:P, N:P, and decreased MBC: MBN. The contents of soil C, N, P, MBC, MBN and Ure, Acp, Cat, and Suc decreased with the deepening of soil depth. With the extension of nitrogen application time, the soil C, P, MBC, and MBN contents reached the maximum values of 152d, 119d, 89d, and 89d, respectively.【Conclusion】Therefore, exogenous nitrogen input is conducive to the growth of seedling roots, which has a promoting effect on the productivity of *R. pseudoacacia* 'Hongsen', and low nitrogen input can better maintain the stability of the ecosystem. In addition, the results of the comprehensive evaluation index of coupling coordination degree in this study showed that the comprehensive evaluation index of root nutrients was higher than that of soil nutrients, indicating that the nutrient development of the root system of *R. pseudoacacia* 'Hongsen' was better than the development of soil nutrients under the simulated nitrogen deposition environment.

Key words: nitrogen deposition; root; soil; coupling coordination