植物磷素吸收机理研究进展

段永康[1]，杨海燕[2]，吴文龙[2*]，闾连飞[2]，李维林[1*]

（1. 南京林业大学，南方现代林业协同创新中心，林学院，南京 210037；2. 江苏省中国科学院植物研究所，果树研究中心，南京 210014）

摘 要：磷是植物生长发育所必需的营养元素之一，对于植物的新陈代谢及蛋白质、脂肪、碳水化合物和维生素的合成、分解和转化有着重要作用，同时也是构成植物体内 ATP、蛋白等大分子物质的重要组分。在农林业生产中，磷是决定土壤肥力和质量的关键指标，磷肥的施用对植物吸收磷的有效性至关重要。然而，磷肥的来源是一种磷酸盐矿石，属于不可再生资源。据世界磷矿储量估计，在未来 50～100 年内磷酸盐矿石将被耗尽，但是在我国许多农业土壤中仍存在过量施用磷肥的现象。磷素缺乏是限制酸性土壤作物生产潜力发挥的主要因子，为了解决土壤中有效磷含量低的问题，在长期的进化过为程中，植物逐渐形成了一系列响应机制以维持体内磷素水平的稳定。植物可以通过改变根系构型、诱导高亲和磷酸盐转运体、形成菌根共生体、诱导根系分泌有机酸和酸性磷酸酶等多种途径，提高植物吸收、转运和磷利用的效率。植物在养分利用效率上普遍存在着基因型差异，因此探究植物磷素吸收特征及其生理分子机制，对于减少肥料施用、保护生态环境和实现农业可持续发展有重要意义。本文综述了磷对植物生长发育、固磷特性及产量品质等影响，阐述了植物磷高效吸收特征、磷素生理与分子机制及其调控途径，提出筛选磷高效基因、选育高效品种及建立磷高效利用技术等是未来需要攻克的难关，以期实现经济林作物的优质高产，对磷肥的高效利用提供一定的参考依据。

关键词:磷；生长发育；吸收特征；生理；分子机制；调控途径

Research Progress on the Mechanism of Plant Phosphorus Absorption

Abstract: Phosphorus is one of the essential nutrient elements for plant growth and development. It plays an important role in plant metabolism and the synthesis, decomposition and transformation of protein, fat, carbohydrates and vitamins. It is also a major component of ATP, nucleic acid, and protein in plants. An important component of molecular substances. In agricultural and forestry production, phosphorus is a key indicator that determines soil fertility and quality, and the application of phosphate fertilizer is very important to the effectiveness of phosphorus absorption by plants. However, the source of phosphate fertilizer is a kind of phosphate ore, which is a non-renewable resource. According to estimates of world phosphate reserves, phosphate ore will be depleted in the next 50 to 100 years, but there is still a phenomenon of excessive application of phosphate fertilizer in many agricultural soils in my country. Phosphorus deficiency is the main factor limiting the production potential of crops in acid soils. In order to solve the problem of low effective phosphorus content in the soil, in the course of long-term evolution, plants have gradually formed a series of response mechanisms to maintain the level of phosphorus in the body. stable. Plants can improve the efficiency of plant absorption, transport, and phosphorus utilization by changing root architecture, inducing high-affinity phosphate transporters, forming mycorrhizal symbiosis, and inducing root secretion of organic acids and acid phosphatase. Plants generally have genotype differences in nutrient use efficiency. Therefore, exploring the phosphorus absorption characteristics of plants and their physiological and molecular mechanisms is of great significance for reducing fertilizer application, protecting the ecological environment and realizing sustainable agricultural development. This study reviewed the effects of phosphorus on

plant growth and development, phosphorus fixation characteristics, yield and quality, and expounded the characteristics of high-efficiency phosphorus absorption, phosphorus physiology and molecular mechanisms and regulatory pathways, and proposed screening phosphorus-efficient genes, breeding high-efficiency varieties and establishing High-efficiency utilization technology of phosphorus is a difficult problem that needs to be overcome in the future, in order to achieve high-quality and high-yield economic forest crops, and provide a certain reference for the high-efficiency utilization of phosphate fertilizer.

Keywords: Phosphorus; Growth and development; Absorption characteristics; Physiology; Molecular mechanism; Regulation pathway