Rhizosphere processes and nutrient management for improving nutrient use efficiency in macadamia in China

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Macadamia species were introduced to China in the 1970s. At present, the planting area of Macadamia in China is over 150,000 hectares. It is estimated that China becomes one of the largest countries in Macadamia planting scale in the world. According to the government's plan, in 2020, Macadamia planting area in just sole Yunnan province is projected to reach 260,000 hectares. The market potential of China's Macadamia industry is enormous based on the estimate.

For a long time, the agronomic management of Macadamia in China is very extensive, especially nutrient management with lack of effective guidance. The time of farmers' fertilization does not match the nutritional needs of macadamia. Farmers directly apply the fertilizers to field as a broadcasting way, which greatly reduces the use efficiency of applied fertilizers. The application type of fertilizer is relatively single, mostly with the 15:15:15 (N:P2O5:K2O) compound fertilizer. Compared with the nutrient requirement of Macadamia, the input of nitrogen and potassium is relatively low but the over-application of phosphate fertilizer is very popular. The amount of P2O5 application by farmers is 2 times as much as the recommended rate. Improper fertilization has led to a series of nutritional problems of Macadamia trees: (1) excessive phosphorus application inhibited the biological potential of efficient phosphorus use by Macadamia roots with strong rhizosphere acidification and even caused phosphorus toxicity; (2) high application rates of phosphorus fertilizers also caused the lack of middle and trace elements, resulting in sub-health problems for most Macadamia trees. It is necessary to establish an optimized fertilization management strategy to match the plant, soil and local ecological conditions in China.

Macadamia is a typical crop with cluster root as a powerful "weapon" to mobilize soil phosphorus through carboxylate exudation and proton release by the special root clusters, which is induced by phosphorus deficiency. Cluster root and mycorrhizae are two adaptive mechanisms for enhancing phosphorus acquisition. Although most of the Proteaceae plants with cluster root cannot be infected by mycorrhizal fungi, Macadamia is a typical mycorrhizal plant. According to the natural infection rate in Macadamia orchard, it was found that Macadamia’s cluster roots were more susceptible to infection of mycorrhizal fungi than non-cluster roots. It is proved that investigating the rhizosphere processes and relationship between mycorrhizal infection and cluster root growth in Macadamia is critical to develop rhizosphere management strategy to increase nutrient use efficiency and nut yield with less input in China.