

Feature Review

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Nutrient Regulation for Improving Pear Fruit Size and Sugar Content

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Abstract The size and sweetness of pears (*Pyrus* spp.) influence people's preferences and market prices. This study explored the effect of dietary regulation on pear fruits, with a focus on three major nutrients - nitrogen, phosphorus and potassium, and also involved trace elements, such as boron, zinc and copper. It analyzed the roles of these nutrients in fruit cell division, the transport of water and nutrients within plants, sugar changes, and the energy distribution between leaves and fruits. The results show that potassium is a key factor, which can activate sugar transportation-related genes (such as *SUT* and *SWEET*), allowing more sugar to enter the fruit and making pears larger and sweeter. When growers apply bio-organic fertilizers simultaneously or spray trace elements on the leaves, the sugar-acid ratio is further optimized and the flavor of the pears is also better. Actual cases have also verified this point: increasing the application of potassium fertilizer can boost the yield of pears, while supplementing boron and zinc improves the appearance of the fruit, making it more market-attractive. It indicates that the best way to manage pears is to apply fertilizers in a balanced manner, in stages, and by combining organic and mineral fertilizers. This study provides fruit farmers with more scientific and targeted guidelines for pear tree management.

Keywords Pear (*Pyrus* spp.); Nutrient regulation; Sugar accumulation; Potash fertilizer; Bio-organic fertilizer; Precision fertilization

1 Introduction

Pears (*Pyrus* spp.) are one of the world's most important fruits. Their size and sweetness decide how popular they are, and how much they sell for. In local markets and in exports, big and sweet pears are always in demand. They bring farmers more money and keep the pear industry steady and growing (Liu et al., 2019; Zhang et al., 2024). But just planting more trees or only chasing higher yields is not enough to keep the pear industry strong. People now want better fruit, not just more fruit. This change is pushing farmers to rethink how they grow pears. To make the fruit taste better and look better, farmers need to keep looking for new ways and new tools.

The economic value of pears is high, but growing big and sweet fruit all the time isn't easy. Things like genetic differences, lack of nutrients, bad weather, and plant diseases, can make pears smaller or less sweet (Sete et al., 2019; Zhang et al., 2024). Too much fertilizer or using it the wrong way can make the problem worse. It not only hurts the quality of the fruit, but also causes harm to the environment (Prasad and Bora, 2015).

N, P and K, along with trace elements like boron, zinc and copper, are all important for pear growth. Among them, K is the most critical. It helps plants make, move and store sugar, which makes the fruit sweeter and helps pears grow bigger (Shen et al., 2016; Zhang, 2019). N and P also help fruit develop and boost yield, but their effect on sugar levels is not always the same. This means, farmers need to manage them carefully (Sete et al., 2019; Li et al., 2024). Trace elements, like boron and copper, are often sprayed on the leaves. They help flowers turn into fruit, support sugar buildup, and improve the overall quality of the pears (Gilani et al., 2021; Sajid et al., 2022).

For pears to grow smoothly and become sweet, nutrients and sugar must be transported smoothly from the "source" (leaves) to the "reservoir" (fruits). In this process, P not helps plants build nutrient transport channels, activates key transport genes such as *SUT*, *SOT* and *SWEET* (Shen et al., 2018; 2019; Gu et al., 2021; Wang et al.,