radish can effectively suppress overwintering annual weeds that emerge in autumn and early spring, reducing the need for herbicide applications before planting subsequent crops.

In vegetable rotation systems and high-tunnel production systems, overwintering cover crops, including radish, can also promote soil biological activity and nitrogen cycling without reducing the yield of subsequent cash crops. These benefits contribute to long-term soil health maintenance and improve the resilience of agricultural systems to environmental stress (Perkus et al., 2022; Elhakeem et al., 2023; Wang et al., 2023).

7 Case Studies of Winter Radish Production Systems

7.1 Case study in the Yangtze River delta region

The Yangtze River Delta region, including Shanghai and Zhejiang, is one of the major autumn-winter radish production areas in China. It is characterized by a temperate-subtropical monsoon climate and highly intensive vegetable rotation systems. Field experiments conducted in Zhejiang and Shanghai showed that radish is commonly grown as a rotational crop after rice or leafy vegetables. Although its growing period is relatively short, the input levels of nitrogen (N), phosphorus (P), and potassium (K) are generally high (Zhang et al., 2019b). The use of scientific nutrient management tools such as the QUEFTS model and Nutrient Expert for balanced fertilization can significantly improve fleshy root yield and nutrient use efficiency compared with traditional farmer fertilization practices (Figure 2). These results indicate that science-based fertilization management plays an important role in supporting the high-input winter production systems in this region.

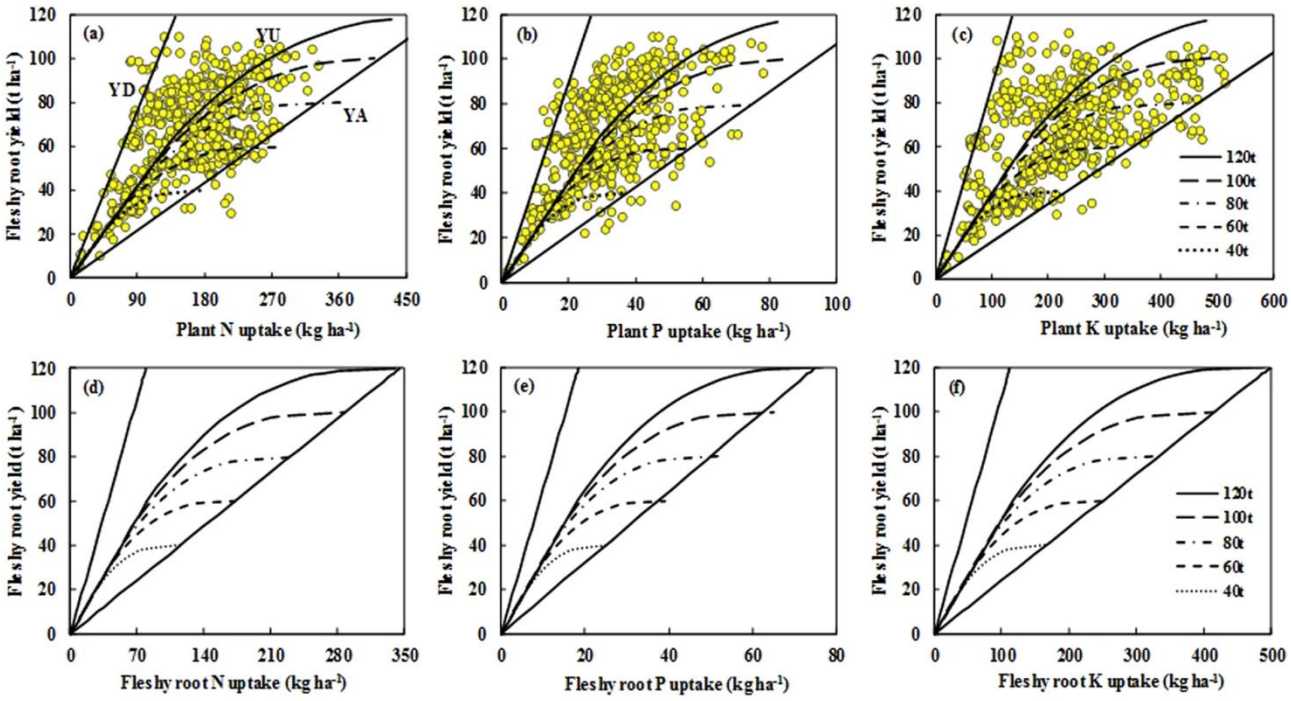

Figure 2 Relationships between fleshy root yield and N, P, and K accumulation in the total plant dry matter at maturity (a-c) and fleshy root N, P, and K removal in fleshy root dry matter (d-f) under different potential yields predicted by the QUEFTS model. YD, YA, and YU represent the maximum dilution, maximum accumulation, and balanced uptake of N, P, and K in the total plant dry matter or in the fleshy roots dry matter, respectively. These parameters were calculated by the QUEFTS model after excluding the upper and lower 2.5 percentiles of all internal efficiency data (HI ≥ 0.4). The potential yield ranged from 40 to 120 t ha^{-1} (Adopted from Zhang et al., 2019b)

7.2 Case study in southern China (e.g., Guangdong and Guangxi)

Subtropical regions such as Jiangxi and Chongqing, which represent the warm and humid ecological conditions of southern China, widely practice autumn-winter radish production. These areas are characterized by relatively mild temperatures and considerable variation in soil conditions. Soil organic matter content and available nitrogen, phosphorus, and potassium levels differ greatly among locations. Therefore, site-specific nutrient and water management strategies are required to fully realize yield potential according to local soil characteristics (Zhang et