significantly increase plant biomass, improve soil pH and soil organic carbon content, and alter bacterial community structure, indicating that improvements in soil physicochemical properties and microbial communities can jointly promote the growth of *T. hemsleyanum* (Zhang et al., 2019a).

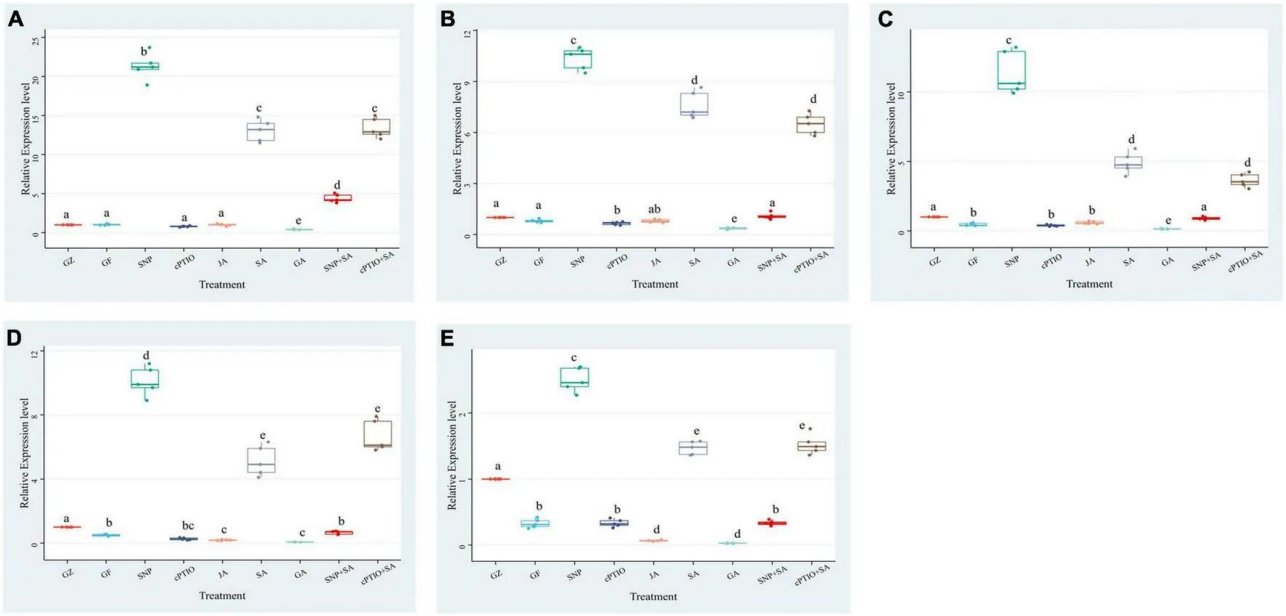

Figure 1 Effect of NO effectors and/or phytohormones on expression levels of (A) *psaL*, (B) *CHIL*, (C) *petF1*, (D) *psbQ*, and (E) *psaE,* of *T. hemsleyanum* under photovoltaic condition (GF) and normal light condition (GZ) (Adopted from Xie et al., 2022)

Image caption: Data are means±SE of the three technical replicates from five seedlings for each treatment; Means that do not share a same letter are significantly different at $p \leq 0.05$ level through Tukey's test (Adopted from Xie et al., 2022)

However, understory soil environments also show variability and limiting factors. In some forestlands, well-developed tree roots may compete with *T. hemsleyanum* for water and nutrients; in low-lying or poorly drained plots, waterlogging may occur during the rainy season, resulting in root hypoxia and tuberous root decay. If understory land lacks long-term management, soil compaction, acidification, or pathogen accumulation may also occur. Therefore, understory cultivation of *T. hemsleyanum* should not rely solely on natural forestland conditions. Instead, soil fertility, permeability, pH, drainage status, and the rhizosphere microbial environment should be comprehensively assessed before planting. Pot experiments showed that pyrolytic organic matter, namely biochar, and organic fertilizer can both increase fresh root weight in *T. hemsleyanum*, with biochar being particularly effective in increasing plant height and total flavonoid content. These effects are associated with increases in soil available nitrogen, available phosphorus, available potassium, organic matter content, and enhanced activities of soil enzymes such as urease, protease, and cellobiohydrolase (Jiang et al., 2023). Therefore, in understory ecological cultivation, soil conditions can be optimized through the application of well-decomposed organic fertilizer, biochar-based fertilizer, drainage ditch construction, and mulching improvement.

Moisture conditions are an important factor affecting the growth of *T. hemsleyanum*. This species prefers humid conditions but does not tolerate long-term waterlogging, and it is suitable for growth in environments with relatively high air humidity, moderate soil moisture, and good drainage. Due to shading and litter coverage, understory environments can usually maintain relatively high humidity and reduce drought stress. However, during the plum rain season or periods of heavy rainfall, an inadequate drainage system may also induce root diseases. Soil microbial communities and rhizosphere conditions in different habitats also play an important role in the quality formation of *T. hemsleyanum*. Stony soils commonly found in mountainous forest terrain can support distinctive bacterial communities and enrich specific groups such as Actinobacteria and Rhizobiales. After two consecutive years of growth in such soils, *T. hemsleyanum* can form larger tuberous roots, and correlation analyses suggest that these microorganisms may promote tuberous root growth by releasing nutrients from rocks and regulating pathways related to phytohormone biosynthesis and stress resistance. Comparative studies of wild