specific stress intensities (Wakchaure et al., 2020). These findings support careful factorial trials in eggplant to identify synergistic PGR combinations and avoid antagonistic or redundant effects.

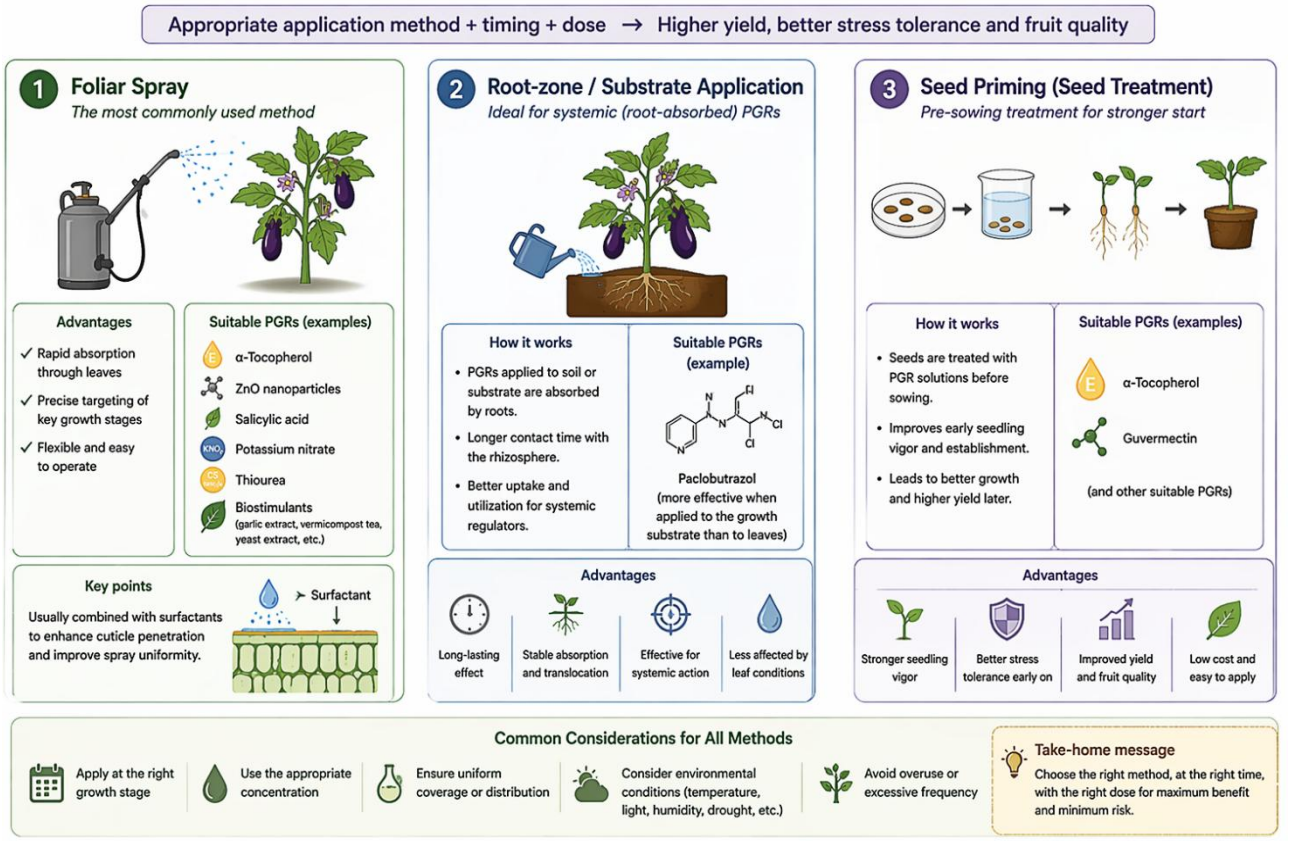

Figure 2 Main application methods of plant growth regulators in eggplant production

Image caption: This figure shows the three main application methods of plant growth regulators in eggplant production, including foliar spray, root-zone or substrate application, and seed priming, and compares their targets, functional features, and practical advantages

6.3 Safety and environmental considerations

Despite agronomic benefits, PGR use raises concerns about residues in edible tissues and broader environmental impacts. Surveys in vegetables have detected multiple endogenous-type PGR residues (auxins, gibberellins, cytokinins) in a high proportion of market samples, with gibberellins sometimes exceeding maximum residue limits set by European, US, and Japanese regulations (Le et al., 2020; Zhou et al., 2025). Reviews highlight mammalian toxicities (hepatic, renal, reproductive, carcinogenic) associated with specific synthetic PGRs, emphasizing the importance of dose-response analysis and rigorous risk assessment (Zhou et al., 2025).

In soils, PGRs undergo adsorption, desorption, hydrolysis, photolysis, and microbial degradation, and their persistence and mobility determine risks to non-target organisms and groundwater (Chen et al., 2022). In some production systems, misuse and overuse have led to declining product quality and dual contamination of crops and cultivation environments, prompting calls for stricter registration, residue limits, and monitoring (Zhang et al., 2020; Zhou et al., 2025).

Sustainable PGR use in eggplant should therefore prioritize: adherence to registered products and label doses; minimal effective application frequency; preference for lower-risk or biogenic regulators and biostimulants where possible; and integration with cultural and irrigation management to reduce dependence on chemical inputs (Akram et al., 2023; Liu et al., 2024). Development of high-throughput residue testing and clearer maximum