(Widiwurjani et al., 2021; Afrin et al., 2024). Under water-scarce conditions, PGRs such as salicylic acid, thiourea, and potassium nitrate help maintain canopy function and fruit quality, supporting yield stability (Wakchaure et al., 2020).

Multiple studies show that appropriate PGR type, concentration, and timing can enhance eggplant yield components, including plant height, leaf area, flower number, fruit number, and individual fruit weight (Wakchaure et al., 2020; Afrin et al., 2024). Yet responses are often genotype- and environment-specific, and sub-optimal doses or combinations may fail to improve final yield due to increased fruit drop or sink regulation by the plant (Alicja et al., 2019). Fruit uniformity is closely linked to processes of flower biology, fruit set, and early fruit development, all of which are hormonally regulated (Bons and Kaur, 2019; Zahid et al., 2022). Differences among flower types (e.g., long vs. short styles) in pollen tube growth, nutrient status, and endogenous hormone balance can determine which flowers set fruit and how fruits develop in size and shape. Transcriptomic analyses further highlight phytohormone-related genes as central regulators of early fruit growth and shape variation (Shi et al., 2023). However, the specific ways exogenous PGRs influence these developmental and physiological mechanisms to improve uniform fruit size and shape in eggplant remain insufficiently characterized.

This study focuses on two central questions: first, whether plant growth regulators can enhance eggplant yield; and second, their roles and underlying mechanisms in improving fruit uniformity. Although field studies on the yield-promoting effects of plant growth regulators in eggplant are relatively abundant, research that treats uniformity as the primary evaluation criterion remains limited. Relevant evidence often needs to be inferred through an integrated assessment of fruit shape formation, floral variation, maturity synchrony, and market quality traits. Accordingly, this study combines evidence from field trial literature with relevant physiological mechanisms to provide a more systematic interpretation of the practical effects of plant growth regulators.

2 Types of Plant Growth Regulators Commonly Used in Eggplant Production

2.1 Auxin regulators and their roles

In eggplant production, the most widely used and common plant growth regulators are still auxin-based compounds, especially IAA, NAA, and 2,4-D. The most direct function of these regulators is to increase the probability of fruit set and, to some extent, reduce flower and fruit drop when pollination is unstable, low-temperature stress occurs, or floral organs develop poorly. Chen et al. (2022) showed that the main purpose of spraying 2,4-D at the flower bud stage in eggplant is usually to reduce floral abscission and promote fruit set. At the molecular level, the SmARF family in eggplant responds significantly to 2,4-D treatment, indicating that the role of exogenous auxin is not simply to “promote fruiting”, but rather to regulate and reshape a whole set of developmental signaling pathways.

NAA has received considerable attention in production practice, partly because of its fruit-setting effect and partly because of its ability to improve fruit shape. Field trial results show that the commonly effective and relatively stable concentration of NAA is usually around 40 ppm. Although the exact value may vary somewhat among cultivars and seasonal conditions, the overall direction of its effect remains consistent. NAA treatment usually increases the effective fruiting rate of long-styled and medium-styled flowers, while also improving leaf photosynthetic capacity and PSII efficiency, which is ultimately reflected in increased fruit number and yield (Moniruzzaman et al., 2014). Amin et al. (2025) tested 40, 50, 60, and 70 ppm NAA together with a control, and the results indicated that 40 ppm was the best treatment: plant height reached 73.73 cm, branch number 9.20, leaf number 97, single-fruit weight 186.67 g, fruit number per plant 10.11, yield per plant 1.31 kg, and estimated yield 41.9 t/ha. This treatment was applied at the 50% flowering stage and again 20 days later. These findings indicate that exogenous auxin regulators can indeed improve fruit set and yield, but their effectiveness depends on an appropriate flowering-stage window and a reasonable concentration; otherwise, excessive hormone application may easily lead to malformed fruits or fruit drop at later stages.