2.3 Types and mechanisms of flower and fruit drop in loquat

Flower and fruit abscission in loquat are caused by physiological and environmental factors. Physiological drop is more associated with abnormal cell division during the early stages of development and hormonal imbalances, particularly with auxin, gibberellin, and ethylene. Environmental aspects are also responsible, with genes like EjBZR1 playing a negative role in cell expansion and fruit growth and thus influencing the fruit drop tendency (Su et al., 2021). Environmental stresses like high temperature and nutritional deficiency also induce flower and fruit drop via the disruption of hormonal regulation and cell activities (Huang et al., 2021). Understanding of these mechanisms will further be helpful in devising methods for enhancing fruit set and yield in loquat.

3 Common Types and Functional Characteristics of Plant Growth Regulators

3.1 Auxins

Auxins are regulators of plant growth involved in the regulation of cell elongation, root formation, and organogenesis. Auxins are the central hormones in coordinating the plant response to external stimuli, and they constantly interact with other hormones in the regulation of synthesis, transport, and signal transduction. Auxins also play a role in fruit set, development, and abscission and typically synergize or antagonize other hormones to regulate plant growth and stress (Mazzoni-Putman et al., 2021; Thapa et al., 2024).

3.2 Gibberellins

Gibberellins are mostly involved in triggering stem elongation, seed germination, and flowering. Gibberellins are responsible for vegetative to reproductive transition growth and participate in fruit development and ripening. Gibberellins interact with other hormones such as auxins and abscisic acid and control growth and developmental processes, and their use may enhance fruit set and quality (Waadt et al., 2022; Jain et al., 2023).

3.3 Cytokinins

Cytokinins are shoot growth and cell division promoters. Cytokinins are the primary regulators of organogenesis, and they also delay leaf senescence and control mobilization of nutrients. Cytokinins act in conjunction with auxins to control root and shoot growth and can potentially control abiotic stress responses by impacting hormonal crosstalk as well as gene expression (Thapa et al., 2024).

3.4 Ethylene regulators

Ethylene is a gaseous hormone which controls fruit ripening, senescence, and abscission. Ethylene regulators suppress or stimulate ethylene action and can impact processes such as flower opening, fruit ripening, and stress responses. Ethylene opposes the action of abscisic acid and co-operates with auxins and cytokinins in various physiological activities (Jain et al., 2023).

3.5 Abscisic acid and other novel growth regulators

Abscisic acid (ABA) is a key stress-response hormone that mediates stomatal closure, seed dormancy, and drought and salt tolerance (Li, 2024). ABA interacts in a complex manner with auxin, cytokinin, and ethylene to regulate growth in response to stress. Other recently discovered growth regulators, such as brassinosteroids, jasmonic acid, salicylic acid, and strigolactones, also play significant roles in plant growth and stress adaptation, which tend to include intricate signaling processes and communication with classical hormones (Sabagh et al., 2021; Zahid et al., 2023; Ochatt, 2024) (Figure 2).

4 Mechanisms of Plant Growth Regulators in Enhancing Loquat Fruit Set

4.1 Regulation of hormonal balance and ovule development

Plant growth regulators such as auxins, gibberellins, cytokinins, and abscisic acid play a central role in regulating endogenous hormone levels to facilitate ovule production and fruitful reproduction. Exogenously applied PGRs may control the hormone balance to initiate division and differentiation within the reproductive organs, which maintains ovule viability and fertilization. For example, paclobutrazol changes the gibberellin, abscisic acid, and cytokinin levels, which lead to improved fruit set and quality because of its influence on hormonal regulation and inducing carbohydrate storage in young fruits (Bons and Kaur, 2019).