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Editorial: Regulation of ovule and seed development

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Editorial on the Research Topic
Regulation of ovule and seed development

Introduction

Seeds and their products play pivotal roles in agriculture and its sustainability by influencing global food security and crop productivity. Plant reproduction and seed take central stage in increasing biodiversity and plant evolution, offering the potential resilience of the offspring to the changing environment (Pereira and Coimbra, 2019). The developmental processes behind ovule and seed formation are intricately regulated by genetic, physiological, and environmental factors. Enhanced understanding of the ovule/seed-associated characteristics and manipulation of molecular machineries to adapt and cope with climate change are crucial for food safety in the future (Reed et al., 2022; Sinha et al., 2021). This Research Topic, "*Regulation of ovule and seed development*," explores these dynamics and presents diverse studies that advance our understanding on the subject.

Current Research Topic delves into subjects ranging from fundamental mechanisms of reproductive biology to practical strategies for enhancing crop resilience under environmental stresses. Since seed-based traits are pivotal in maintaining and conferring biodiversity, insights into their development and adaptation are critical to cope with issues like climate change, food scarcity, and effective management of underutilized marginal lands.

This focused Research Topic presents four unique contributions, each offering insights into different aspects of plant reproduction and seed-related traits. While some of these studies align directly with ovule and seed development, others provide complementary perspectives, broadening the narrative of the Research Topic.

Unraveling male gametogenesis: auxin's role in pollen development

Seed development *via* sexual reproduction essentially relies on the successful delivery of male gametes to fuse with egg cell residing in the embryo sac of female gametophyte. Hence, coordinated and precise development of male and female gametes is essentialin the process. Here, Cui et al. discuss the molecular mechanisms behind microsporogenesis and micro-gametogenesis with references to recent relevant studies. The authors highlight the

crucial role of auxin in defining archesporial cell specialization and the importance of pre-mitotic microspore maturation and offer prospects for future studies.

Climate stress and seed development: adapting for resilience

The relevance of environmental stresses to seed development is explored by Erfatpour et al., who examined the impacts of climate change on reproductive success across crop species. By integrating evidence on the effects of temperature, drought, and salinity, they highlight the vulnerability of ovule and seed formation to abiotic stress. This work underscores the need for climate resilient crops and adaptive agricultural practices. Importantly, the authors also propose future research directions, such as identifying genetic pathways that can be harnessed for breeding stress-tolerant crop varieties.

Cracking cotton's genetic code: the HACD pathway in seed oil biosynthesis

Expanding the focus to molecular mechanisms, Yan et al. investigate the HACD gene family in cotton (*Gossypium hirsutum*). Their study identifies *GhHACD2* as a key regulator of very long-chain fatty acid biosynthesis, a trait that influences cottonseed oil content and quality. The authors, however, also observed its higher expression in the low oil-producing genotype at the critical oil accumulation phase of development as compared to that in the high oil-producing lines. They corroborated their observation with its heterologous expression in yeast and recorded a significant reduction in total oil content. This finding is first of its kind regarding the role of an HACD member in the regulation of cottonseed oil content.

Surviving karst: alfalfa germination under environmental stress

The study by Zhou et al. explores how karst-specific environmental stresses—drought, calcium salts, and pH variations—affect the germination and growth of alfalfa (*Medicago sativa* L.), an important forage crop of the karst region. The study observed that the root systems of the seedlings are more sensitive to the assessed abiotic stresses. The findings made in the study offer a reference for screening and selection of suitable plants to cultivate in the karst region.

Collectively, the four studies presented in the Research Topic focused on ovule and seed spanning from gametophyte development to seed germination. By addressing diverse aspects of ovule and seed biology, they contribute significantly to advancing this critical field. The insights presented here are expected to contribute future research directions in this important research field by integrating molecular biology, genetics, and applied agronomy to develop resilient crop systems.

We are grateful to the authors and reviewers who contributed their expertise to this Research Topic, enriching our understanding of the field relevant to ovule and seed development and its broader future prospects.

Author contributions

PA: Writing – original draft, Writing – review & editing. RD: Writing – review & editing. RK: Writing – review & editing.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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