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Effect of Drought Stress on Seed Germination and Early Seedling Growth of Petunia

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Abstract

Drought stress is a major factor limiting seed germination and early seedling growth in plants. This study evaluated the effects of drought stress on germination and early seedling development of *Petunia hybrida*. Drought stress was simulated using polyethylene glycol (PEG 6000) at concentrations of 0, 5, 10, and 15%. Seeds were germinated in Petri dishes under controlled conditions (25 ± 2°C, 12 h light/12 h dark) and monitored daily for 10 days. Germination percentage, germination rate, root length, and shoot length were measured. Results indicated that increasing PEG concentrations significantly reduced germination percentage and rate, with the highest values in the control (0% PEG, 92%, 8.5 day^{-1}) and the lowest at 15% PEG (31.2%, 2.9 day^{-1}). Early seedling growth was similarly inhibited, with root length more sensitive than shoot length. These findings demonstrate that *Petunia* seeds are highly sensitive to water deficit during germination and early development, highlighting the importance of adequate water supply and providing insights for improving drought tolerance in ornamental plant cultivation.

Introduction

Seed germination and early seedling growth are critical stages in the plant life cycle, directly affecting establishment, growth, and survival (Li et al., 2013). Adequate water availability is essential for initiating metabolic activity, enzyme activation, and cellular expansion during germination (Beyaz, 2023). Water deficit can disrupt these processes, leading to delayed or inhibited germination, reduced seedling vigor, and decreased overall plant performance (Pham et al., 2023).

Osmotic stress reduces water uptake, inhibits enzymatic activity, and limits mobilization of stored seed reserves necessary for radicle emergence (Garg, 2010).

Materials and methods

Certified uniform seeds of *Petunia hybrida* were obtained from a Pakan Bazr commercial supplier. Seeds were surface-sterilized with 1% sodium hypochlorite for 2 minutes, rinsed with distilled water, and air-dried at room temperature.

Results and discussion

PEG-induced drought stress significantly affected germination of *Petunia* seeds (Table 1). Increasing PEG concentrations caused a progressive decline in germination percentage and germination rate. The control (0% PEG) exhibited the highest germination (92%) and rate (8.5 day^{-1}), while the 15% PEG treatment showed the lowest (31.2% and 2.9 day^{-1}).

The reduction in germination can be attributed to osmotic stress, which limits water uptake by seeds, slows metabolic activation, and delays radicle emergence (Li et al., 2013; Beyaz, 2023). Similar results have been reported in ornamental species such as *Lilium* and *Petunia* as well as crop plants like *Phaseolus mungo*, where PEG-induced drought stress reduced germination percentage and delayed germination rate (Garg, 2010; Guo et al., 2024).

Reduction in germination percentage and rate under increasing PEG concentrations is consistent with reports in other ornamental and crop species (Li et al., 2013; Garg, 2010). Delayed germination and reduced root growth under osmotic stress may limit seedling establishment in field conditions.

The results also highlight that fresh weight, representing the total biomass of the plant, is closely linked to the plant's ability to take up water, while dry weight reflects the efficiency of metabolic and growth processes. Both parameters decreased progressively as the PEG concentration increased, reinforcing the idea that water deficit severely impacts overall plant health, especially in early developmental stages.

References

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