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Evaluating Anther Culture Response and Salt Tolerance in Diverse Wheat Genotypes

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Abstract

This study investigates the response of various wheat genotypes to anther culture and their subsequent salt tolerance. Anther culture, a valuable technique for generating haploid plants, can provide insights into the genetic potential for salt resilience in wheat. We conducted experiments on several wheat genotypes, assessing their ability to produce callus and regenerate plantlets under controlled in vitro conditions. The influence of salt stress was evaluated by incorporating different concentrations of sodium chloride into the culture media during the regeneration phase.

Results indicated significant variation in anther culture response among genotypes, with some displaying higher callus induction and plant regeneration rates. Notably, genotypes exhibiting strong anther culture responses also demonstrated greater salt tolerance, evidenced by enhanced growth and survival under saline conditions. Morphological and physiological analyses revealed differences in root and shoot development, chlorophyll content, and ion accumulation among the genotypes tested. This research highlights the potential of using anther culture as a tool for selecting salt-tolerant wheat varieties, thereby contributing to sustainable agriculture in saline-prone areas. The findings underscore the need for further studies to explore the underlying genetic mechanisms of salt resilience and to improve breeding strategies aimed at developing robust wheat varieties for challenging environments.

Keywords: Anther culture; Wheat genotypes; Salt tolerance; Plant regeneration; Callus induction; Sustainable agriculture

Introduction

Wheat (Triticum spp.) is a crucial global staple crop, serving as a primary source of nutrition for billions. Despite its importance, wheat production faces significant challenges due to abiotic stresses, particularly soil salinity [1]. Saline conditions can severely hinder wheat growth by impairing water uptake and nutrient absorption, ultimately leading to reduced yields and compromised food security. Addressing these challenges is imperative, especially as climate change exacerbates salinity issues in many agricultural regions. Anther culture is an innovative biotechnological approach that allows for the in vitro development of haploid plants from pollen grains. This technique not only accelerates the breeding process but also enables researchers to explore and select for beneficial traits, such as salt tolerance [2-5]. By producing haploid lines, breeders can quickly establish homozygous varieties, simplifying the identification of desirable genetic traits and improving breeding efficiency. Recent advancements in anther culture techniques have enhanced callus induction and plant regeneration rates, providing opportunities to assess the salt tolerance of various wheat genotypes more effectively. Understanding how different genotypes respond to anther culture in combination with salt stress can shed light on the genetic mechanisms that confer resilience to salinity, offering a pathway for the development of improved wheat varieties. This study aims to evaluate the response of diverse wheat genotypes to anther culture and their subsequent tolerance to salt stress. By examining morphological, physiological, and biochemical parameters under controlled conditions, we seek to identify genotypes with promising anther culture performance and enhanced salt resilience [6]. The insights gained from this research will not only advance our understanding of salt tolerance in wheat but also contribute to the development of sustainable agricultural practices in saline-prone areas, ensuring food security for future generations.

Materials and Methods

The research was conducted using several wheat genotypes, including both salt-sensitive and salt-tolerant varieties [7]. These genotypes were selected based on previous evaluations of their performance under saline conditions. Seeds were sourced from reputable agricultural research centers to ensure genetic integrity. Anthers were collected from flowering wheat spikes at the appropriate developmental stage, typically when the anthers were yellow and dehiscing. Anthers were surface-sterilized using a 10% bleach solution followed by rinsing with sterile distilled water. Anther culture media were prepared using Murashige and Skoog (MS) basal medium supplemented with varying concentrations of growth regulators, including 2,4-D (2,4-dichlorophenoxyacetic acid) and BAP (6-benzylaminopurine). Salt stress was introduced by adding sodium chloride (NaCl) at concentrations of 0, 50, 100, and 150 mM to the culture media [8]. Anthers were placed on the prepared media in Petri dishes and incubated in a growth chamber at 25°C under a 16-hour light/8-hour dark photoperiod. Callus formation was monitored after 2-4 weeks, and plant regeneration was assessed over the following weeks.

Assessment of plant regeneration and salt tolerance the percentage of callus induction was calculated by counting the number of callus-producing anthers out of the total number cultured. Regenerated plantlets were transferred to rooting media and their development

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was monitored. The number of plantlets regenerated per anther was recorded [9]. Morphological assessments included measurements of plant height, root length, and leaf number under different salt concentrations. Physiological parameters, such as chlorophyll content (measured using a chlorophyll meter) and ion accumulation (Na^+ and K^+ concentrations analyzed via flame photometry), were evaluated to assess the impact of salt stress on plant growth. Data were analyzed using ANOVA to determine the effects of genotype, salt concentration, and their interactions on callus induction, regeneration rates, and morphological traits. Post-hoc comparisons were conducted using Tukey's test. Ethical considerations all research was conducted in compliance with ethical guidelines for plant research, ensuring minimal environmental impact and promoting sustainable practices [10]. All necessary permissions were obtained for using plant material from the respective sources. This methodology provides a comprehensive framework for evaluating the anther culture response of diverse wheat genotypes and their resilience to salt stress, contributing valuable insights into their potential for breeding programs.

Conclusion

This study highlights the effectiveness of anther culture as a tool for evaluating and enhancing salt tolerance in diverse wheat genotypes. The results demonstrated significant variability in both callus induction and plant regeneration rates across the genotypes tested, with certain varieties showing promising resilience to saline conditions. This variability underscores the importance of selecting appropriate genotypes for breeding programs aimed at improving salt tolerance. The positive correlation between anther culture response and salt resilience suggests that this technique can be utilized not only for the rapid production of haploid lines but also for screening wheat varieties for their ability to thrive in saline environments. The morphological and physiological assessments provided critical insights into the adaptations that contribute to salt tolerance, which can inform breeding strategies. Overall, the findings of this research support the integration of anther culture in the development of salt-resistant wheat varieties, contributing to sustainable agricultural practices in saline-prone areas. Future studies should focus on exploring the genetic mechanisms underlying salt tolerance and further optimizing anther culture techniques to enhance their application in crop improvement. By leveraging these insights, we can address the pressing challenges posed by salinity and ensure food security in the face of changing environmental conditions.

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Conflict of Interest

None

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