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Effects of Melatonin Seed Priming in Waxy Corn on Germination under Salinity Stress

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ABSTRACT

Salinity stress is a major abiotic stress affecting corn germination and growth. Melatonin, known to regulate physiological functions in animals, is now identified as a plant hormone that reduces abiotic stress by regulating antioxidant defense and improving osmotic balance. However, its role in waxy corn germination is unclear. This study investigated the effects of seed priming with melatonin on waxy corn germination under salinity stress. Seeds were primed with melatonin (0, 100, 200, 300 and 400 µM) for 24 h and germinated under 100 µM NaCl stress for six days. Melatonin at 200 µM enhanced waxy corn germination, showing greater coleoptile length, radicle length, biomass, germination energy, and vigor index. This study highlights melatonin's potential as an affordable and sustainable method to reduce salinity stress in waxy corn production, potentially increasing agricultural output in salinity-affected areas.

Keywords: Germination, melatonin, salinity stress, seed priming, waxy corn

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INTRODUCTION

Waxy corn cultivation in saline soils faces significant challenges due to reduced germination rates and inconsistent yield (Askari et al., 2023). Salinity impacts vital metabolic functions like protein synthesis and lipid metabolism due to ionic and osmotic stress. Strategies to mitigate salinity stress focus on preserving osmotic homeostasis and ion balance (Wang et al., 2013). Melatonin, an indoleamine

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compound, has recently become a major focus for overcoming abiotic stresses in plants, promoting resilience to salt, drought, heat, and cold (Tiwari et al., 2020).

Problem Statement

Current use of melatonin application results in unpredictable and inconclusive outcomes.

Research Questions

What is the lowest effective concentration of melatonin to improve waxy corn germination under salt stress?

MATERIALS AND METHODS

Seed Priming with Melatonin

Fungicide-treated waxy corn seeds were soaked in melatonin solutions (0, 100, 200, 300, and 400 µM) for 24 h at 25°C in the dark with gentle stirring.

Germination and Salinity Stress Induction

Primed seeds were germinated on sterile filter paper moistened with 100 µM NaCl and germinated for 6 days under 12:12 hours of light/dark conditions at 25°C.

Germination Characteristics Determination

Coleoptile and radicle length were recorded manually. Biomass accumulation was determined by drying at 80°C for 24 h. Germination parameters—mean germination time (MGT), germination rate index (GRI), germination percentage (GP), germination energy (GE), and vigor index (VI)—were calculated using standard formulas (Yang et al., 2021).

Statistical Analysis

Data were analysed using SPSS20 with one-way ANOVA ($P \leq 0.05$). Tukey's HSD was used for multiple comparisons.

RESULTS AND DISCUSSION

Melatonin Sustained Early Growth under Salinity Stress

Early growth data showed coleoptile and radicle lengths increased significantly at 200 µM under both stressed and unstressed conditions, indicating melatonin's stimulatory effects on cell division and elongation (Table 1). This supports previous research that melatonin increases auxin-related gene expression, promoting plant elongation (Zhang et al., 2022).

Table 1
Early germination growth parameters of waxy corn seeds treated with melatonin (MEL) with and without application of NaCl (n=20, P≤ 0.05)

MEL (µM)	Coleoptile length (cm)		Radicle length (cm)		Fresh weight (g)	
	-Nacl	+Nacl	-Nacl	+Nacl	-Nacl	+Nacl
0	1.33±0.10[a]	0.40±0.00[a]	0.41±0.00[a]	0.24±0.03[a]	3.00±0.00[a]	1.20±0.20[a]
100	2.67±0.10[b]	0.50±0.00[a]	0.42 ±0.01[ab]	0.25±0.02[a]	3.40±0.26[a]	2.03±0.06[b]
200	3.13±0.06[bc]	0.63±0.06[b]	0.43±0.01[bc]	0.34±0.03[b]	4.97±0.15[b]	2.27±0.12[b]
300	4.40±0.36[c]	0.83±0.06[c]	0.44±0.01[c]	0.36±0.01[b]	5.30±0.10[b]	3.00±0.20[c]
400	5.57±0.33[d]	1.23±0.06[d]	0.46±0.01[d]	0.38±0.01[b]	8.07±0.25[c]	3.70±0.20[d]

Fresh weight (biomass) was consistently lower under stress, highlighting NaCl's adverse effects. However, melatonin application as low as 100 µM significantly improved biomass, possibly due to its role in regulating carbon and nitrogen assimilation (Qin et al., 2023).

Melatonin-primed Seeds Possessed Better Germination Qualities

Germination parameters were obtained from four replicates of five seeds each. Mean germination time (MGT) remained consistent (3.5-3.7 days), suggesting melatonin may not speed up germination but promotes consistency under stress (Chen et al., 2021). Germination rate index (GRI)results were inconsistent, indicating melatonin improves germination efficiency and uniformity rather than rate (Zeng et al., 2022). No significant difference was found in GP while GE showed no clear pattern. However, VI showed significant differences at all melatonin concentrations, with or without NaCl. This suggests that melatonin may strengthen the antioxidant defense system.

CONCLUSION

Melatonin effectively mitigated the negative effects of salinity stress in a dose-responsive mannerwith a concentration of 200 µM was sufficient to exert positive effects.

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