

WSU Plant Pathology Seminar

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Enhancing Soybean Resilience: Nitrogen Fixation Strategies for Heat Stress Adaptation



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Abstract: Soybean (*Glycine max* L.) is an important crop for global protein and oil production, yet its productivity is increasingly threatened by rising temperatures due to climate change (Poudel et al. 2024). Even a 1% increase in average growing season temperature can lead to a 3.1% yield decline, underscoring the urgent need for strategies to enhance heat resilience (Khan et al. 2020). Maintaining biological nitrogen fixation (BNF) is a promising approach to mitigate heat-induced yield losses (Chen et al. 2019), and recent advances have identified multiple strategies to improve BNF under heat stress. Transgenic soybeans overexpressing *GmHSP17.9* (small heat shock proteins; sHSP) showed a 30.2% increase in nodule number, a 65.9% rise in nodule fresh weight, and a 28.2% boost in nitrogenase activity compared to wild-type plants (Yang et al. 2022). Additionally, molybdenum disulfide (MoS₂) nanoparticles have been demonstrated to promote nodulation, scavenge reactive oxygen species, and improve nitrogenase activity, thereby preserving nodule functionality during stress (Li et al. 2023). These findings highlight genetic and nanomaterial-based strategies to stabilize BNF and mitigate yield losses under high-temperature conditions. Future research should explore the genetic mechanisms behind sHSP-mediated stress tolerance, screen diverse germplasm for heat-

resilient traits, and identify heat-tolerant rhizobial strains (Jianing et al. 2022). Integrating these innovations into breeding programs and agronomic practices could play a pivotal role in sustaining soybean productivity in a warming climate.

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Short biography of Bipin Neupane

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