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COMMENT

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Enhancing waterlogging tolerance in cotton through agronomic practices

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Abstract

Recent publications have highlighted significant progress in utilizing agronomic interventions to alleviate waterlogging stress in cotton production. Based on these advancements, we provide a concise comment on the effects and underlying mechanisms of various strategies such as utilizing stress-tolerant cotton varieties, applying nitric oxide (NO), and implementing ridge intertillage. Finally, we recommend a combination of measures to enhance cotton's ability to withstand waterlogging and reduce yield losses.

Keywords Cotton, Waterlogging, Agronomic practice

The increasing occurrence of global warming and extreme weather conditions has led to waterlogging becoming a significant natural disaster in cotton production globally, including in China (Zhang et al. 2015; 2016). Consequently, there is considerable global interest in enhancing the waterlogging tolerance of cotton through agronomic measures, as a mean to reduce yield decline and economic losses. To this end, recent research conducted by Dong and colleagues has made significant advancements in mitigating waterlogging stress through agronomic interventions. A series of scientific papers on this topic have been published, offering important guidance and viable methods for effectively managing waterlogging stress in cotton (Zhang et al. 2021b; 2022; 2023a; 2023b).

Despite the existence of studies exploring genotypic variations in cotton waterlogging tolerance, there is a dearth of research on the differences in waterlogging tolerance among specific Chinese commercial cotton varieties, particularly in relation to their geographical origin. It remains unclear whether waterlogging tolerance is influenced by the geographical source of the cotton variety. To address this knowledge gap, Zhang et al. (2023b) conducted a comparative study on waterlogging tolerance among commercial cotton varieties from three major cotton-producing regions in China. Findings from this study revealed that cotton varieties from the Yangtze River valley exhibited the lowest percentage of seed cotton yield loss and biomass loss, followed by cotton varieties from the Yellow River valley. Conversely, cotton varieties from the Northwest Inland region experienced the highest percentage of yield loss and biomass loss. Interestingly, varieties from the Yangtze River valley, characterized by higher precipitation levels, displayed greater waterlogging tolerance compared with other regions. These results signify that cotton varieties originating from the Yangtze River valley exhibit higher waterlogging tolerance in comparison to those sourced from other geographic locations. The insights from this study provide valuable implications for the breeding and cultivation of waterlogging-resistant cotton varieties.

Timely application of plant growth regulators, such as sodium nitroprusside (SNP), a nitric oxide (NO) donor, can be a promising approach to alleviate waterlogging stress in cotton. Zhang et al. (2021b) reported that the appropriate application of SNP increased the NO concentration in waterlogged cotton by 80.2%, and lint yield by 12.0% compared with waterlogged cotton without SNP application. The results indicated that NO plays a

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crucial role in alleviating waterlogging stress through a series of physiological and molecular events, leading to a reduction in biological and lint yield losses. In a recent study conducted by Zhang et al. (2022), it was demonstrated that foliar spraying of SNP during waterlogging not only increased the NO concentration (40% ~ 183%) before stress relief, but also increased the NO concentration (30% ~ 75%) after stress relief. Nitric oxide not only improves the adaptability of cotton to waterlogging stress by mitigating hypoxia damage but also enhances compensatory growth after waterlogging, ultimately reducing yield loss. Consequently, increasing the concentration of NO in plant tissues through genetic breeding or agronomic measures represents a potential strategy to improve cotton's waterlogging tolerance and reduce yield loss.

Ridge intertillage is a traditional cultural practice that involves forming ridges along cotton rows and furrows between rows before flowering. This practice has been used to reduce lodging and control weeds in cotton fields. In a recent study, Zhang et al. (2023a) found that the lint yield of cotton plants under flat intertillage decreased by 23.0% under 10 days of waterlogging stress. However, for waterlogged cotton plants that underwent intertillage before flowering, the lint yield only decreased by 9.5%. Compared with traditional flat intertillage, ridge intertillage resulted in a 52.3% reduction in yield loss of seed cotton and a 61.3% reduction in yield loss of lint due to waterlogging. The above results indicates that ridge intertillage can have a significant impact on reducing yield loss caused by waterlogging. The improved rhizosphere microbial community in the intertilled soil enhanced nutrient absorption but reduced membrane lipid peroxidation in waterlogged cotton plants. This helped alleviate anaerobic respiration and its negative effects on plant growth. Taken together, ridge intertillage as a cultural practice can significantly mitigate the negative effects of waterlogging on cotton yield.

Based on the findings and conclusions, as well as inspiration from previous research on genotype × environment × management interactions (Zhang et al. 2021a; 2023b), we suggest a combination of measures to enhance cotton's waterlogging tolerance but reduce yield loss. These measures include selecting waterlogging tolerant varieties, implementing agronomic practices like ridge intertillage, and using plant growth regulators like NO. Therefore, further research, demonstration, and adoption of this integrated approach can lead to more effective and reliable methods in improving waterlogging tolerance in cotton crops.

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