Cassava root phenotyping for arsenic phytoremediation

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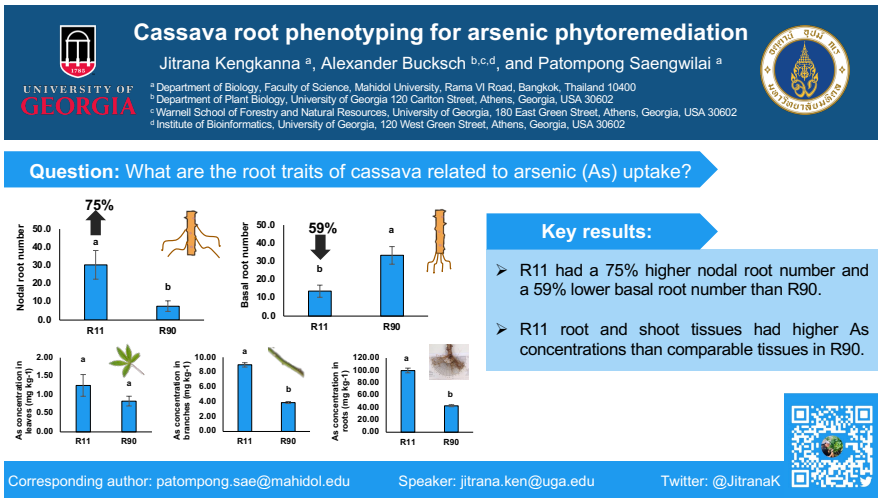
November 30, 2022

Abstract

Arsenic (As) pollutes large regions of Asia. Despite phytoremediation initiatives using hyperaccumulators to remove As from contaminated soil, farmers remain reluctant to employ such strategies because of the low biomass and economic value of hyperaccumulating plants. In this study, we demonstrate that cassava can be used for As remediation using a high-throughput root phenotyping platform for cassava roots that we previously developed [1]. Using this phenotyping platform, we identified contrasting root traits associated with As uptake for the two genotypes Rayong 11(R11) and Rayong 90 (R90). Both cassava varieties were grown in pot systems under control (0 mg kg-1 As) and high As (50 mg kg-1 As) conditions and harvested 120 days after planting. We found As stress to reduce shoot and plant dry weight by 57% and 53%, respectively, whereas root dry weight and root traits showed only a slight change. Under As stress, R11 had a 75% higher nodal root number and a 59% lower basal root number than R90. Moreover, R11 root (100 mg kg-1 As) and branch (9 mg kg-1 As) tissues had considerably higher As concentrations than the same tissues in R90. The bioaccumulation coefficient for R11 (2.1) was significantly greater than for R90 (0.9). Additionally, bioethanol yields were unaffected by the presence of As in cassava starch. We suggest that cassava is a promising crop for phytoremediation and that root phenotyping is essential to breed cassava varieties with enhanced As uptake.



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ABSTRACT

Arsenic (As) pollutes large regions of Asia. Despite phytoremediation initiatives using hyperaccumulators to remove As from contaminated soil, farmers remain reluctant to employ such strategies because of the low biomass and economic value of hyperaccumulating plants. In this study, we demonstrate that cassava can be used for As remediation using a high-throughput root phenotyping platform for cassava roots that we previously developed [1]. Using this phenotyping platform, we identified contrasting root traits associated with As uptake for the two genotypes Rayong 11(R11) and Rayong 90 (R90). Both cassava varieties were grown in pot systems under control (0 mg kg^{-1} As) and high As (50 mg kg^{-1} As) conditions and harvested 120 days after planting. We found As stress to reduce shoot and plant dry weight by 57% and 53%, respectively, whereas root dry weight and root traits showed only a slight change. Under As stress, R11 had a 75% higher nodal root number and a 59% lower basal root number than R90. Moreover, R11 root (100 mg kg^{-1} As) and branch (9 mg kg^{-1} As) tissues had considerably higher As concentrations than the same tissues in R90. The bioaccumulation coefficient for R11 (2.1) was significantly greater than for R90 (0.9). Additionally, bioethanol yields were unaffected by the presence of As in cassava starch. We suggest that cassava is a promising crop for phytoremediation and that root phenotyping is essential to breed cassava varieties with enhanced As uptake.

Keywords: arsenic, root phenotyping, cassava, phytoremediation

[1] Kengkanna, J., Jakaew, P., Amawan, S., Busener, N., Bucksch, A., & Saengwilai, P. (2019). Phenotypic variation of cassava root traits and their responses to drought. *Applications in plant sciences*, *7*(4), e01238.