Estimation of Below Ground Biomass in Cassava by Ground Penetrating Radar

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Rationale for Project

Early bulking varieties shorten the growth period from planting to harvesting, better fit environments with a short rainy season, and reduce exposure to biotic and abiotic stresses thereby increasing productivity. Establishing non-destructive and rapid phenotyping tools to measure these root traits is necessary in root and tuber crops widely used as a food source in impoverished areas.

Objectives

• Define the capability of GPR to phenotype below ground biomass, in the context of early bulking traits in cassava.
• Develop a simple and rapid protocol that will predict root development and root turnover dynamics over time using repeated GPR scans, and further transfer to other root and tuber crops.

Hypothesis

GPR is capable of phenotyping below ground biomass in the context of early root bulking traits in cassava in various field conditions.

Methodology

1) Each variety was located in a specific soil type based on clay content and moisture
2) Pixel intensity thresholding is a multi filtering technique with a spectral analysis component and clustering tool for quantification.
3) Plants were harvested and weighed for correlation with pixel count values.

Ground Penetrating Radar

• Detector DUO (IDS North America)
• Dual channel antenna system
• 700 MHz and 250 MHz frequencies
• Directional pulse spacing of .0134 m

Design

• 3 varieties of Cassava (HMC-1, SM 1219-9, and M-NGA 11)
• 4 planting dates (3 month, 4 month, 5 month, and 6 month)
• 5 m X 1 m plot dimensions
• 5 plants per plot (60 plants total)

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Results (1)

- Greater percent dry weight suggests less moisture presence at time of harvest (i.e. data capture). Relevance found in discussion.

Results (2)

- GPR functions by detecting differences in dielectric between materials. Since water has a greater dielectric than soil the response is greater therefore increased root moisture would facilitate the detection process.
- Lower percent dry weight suggests greater moisture content during harvest and a drier soil suggests that M-NGA 11 would be easier to detect.
- Regression was highly significant for the variety M NGA 11. To test if the significance was due to a particular planting date relationship, a secondary analysis was performed to determine at what stage the correlations were associated to.

Discussion

- Linear regression was found to be most significant when measurements were taken in dry sandy soils. This is synonymous to previous work which elucidated the same relationship when studying root biomass estimations in conifers (3).
- Correlations between planting dates and pixel counts as well as planting date and harvested biomass showed similar trends which strengthen the significant response of the linear regression in M NGA 11.
- GPR was not able to significantly discern biomass in all soil types with low regressions occurring in areas of greater clay content.

Conclusion

- See Reference (1) for pixel intensity thresholding protocol.

Work Cited