

Academy for International Agricultural Research for Development

Junior Scientists Tandems Final Report

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Title: Ecological Relevance of Rhizosphere Hydrophobicity in the Plant-Soil System of African Major Crops under Drought Condition

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Introduction

This report summarizes my career exploration and research stay at the Chair of Soil Biophysics and Environmental Systems, TUM School of Life Sciences, Technical University of Munich, Freising, Germany. I was awarded a six-month career exploration scholarship by the Council for Tropical and Subtropical Agriculture (ATSAF e.V). The experience provided me with a unique opportunity to work in a diverse and dynamic research group, and to acquire valuable scientific and technical skills which will significantly enhance my research progression.



Plates 1 and 2: Working days at TUM

The Research Work

The research titled "*Ecological Relevance of Rhizosphere Hydrophobicity in the Plant-Soil System of African Major Crops under Drought Condition*" investigated how different genotypes of maize, cowpea and soybean respond to varying soil types and moisture levels.

Six genotypes of African maize, three genotypes of cowpea and soybean each were studied in the experiments. Furthermore, six genotypes of German maize were included in the study to compare their performance with those of the African genotypes. All seeds were pre-germinated in 9 cm Petri dishes following standard protocols.



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Plate 3: Pre-germination of seeds

Soil samples were prepared by oven drying at 60 °C for 3 days and grinding with mortar and pestle, followed by sieving with 2 mm mesh. The processed soil was then filled into 0.2 litre planting cups as shown below.



Plates 4 and 5: Soil preparation (Oven drying)





Plates 6 and 7: Filling of planting cups with soil samples

The genotypes were grown in two soil types and moisture conditions as shown below:

Moisture conditions	Sandy Loam	Silt Loam
No Drought	21%	25%
Severe Drought	8-10%	10-12%

The experiment was set up in a climate-controlled room with daily irrigation until two weeks, after which the experiment was terminated. Plants from the severe drought treatment were harvested on the same day the experiment was terminated while those of the no drought treatment had their cups cut open and were left to dry till the following day. The aboveground parts (shoots) of each plant were harvested separately and stored in Ziploc bags. The belowground parts (roots) were carefully separated from the bulk soil to obtain roots with rhizosheaths (region of soil adhering strongly to the root surface). In order to separate the rhizosheath from the root, each root was gently shaken to collect the rhizosheath, after which they were oven dried at 60 °C for 24 hours, milled using the Retsch MM 200 Mixer Mill (Plate 15), and stored in the refrigerator for subsequent carbon content analysis. The root and shoots were scanned using an Epson Perfection V850 Pro Scanner (Plate 16) and analysed with WinRHIZO and Image J software respectively, to obtain data on root length, root area, root



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diameter, shoot length and shoot diameter. Roots and shoots were then placed in plastic bags, oven-dried at 60 °C for 24 hours and weighed on a digital balance to obtain their biomass.



Plate 8: African and German maize Genotypes

Plate 9: Cowpea and Soybean Genotypes



Plate 10: Rhizosheath collection

Plate 11: Working in the climate-controlled





Plate 11: Maize root with rhizosheath

Plate 12: Cowpea root with rhizosheath



Plate 13: Soybean root with rhizosheath

Plate 14: Finely milled rhizosheath in Ziploc bags





Plate 15: Retsch MM 200 Mixer Mill for milling of rhizosheaths

Plate 16: Root and shoot scanning with Epson Perfection V850 Pro Scanner

Our preliminary observation shows that more there were more rhizosheaths formed in maize genotypes, followed by cowpea, and then soybean. In addition, the root system in maize genotypes were more extensive compared to cowpea and soybean. Further data analysis will reveal which genotypes had higher biomass, rhizosheath mass, root traits and carbon contents to support drought resilience.

Interactions and Experiences during the Stay

My host research group exemplifies a diverse and inclusive community with members from countries such as Iran, Nigeria, India, China, Azerbaijan, Germany and Mexico. This gave me the privilege to interact with individuals from different nationalities. I worked with a PhD student, Saniv Gupta and two masters' students – Chetan Gangadharan and Shubh Paliwal on the project and they were quite helpful. My host supervisor, Prof. Mohsen Zare and the Chair Secretary, Ms. Cornelia Wenske ensured that I had I was properly settled in and everything I needed for a successful stay. Dr. Benjamin Hafner, a Postdoc in the team and Daniel-Sebastian Moser assisted me with getting on in the laboratory work and instrumentation. Every member of team always expressed a readiness to assist whenever there was a need. I also had the opportunity to learn on other ongoing projects in the group and acquire relevant skills. Although I had a lot of work to do, I enjoyed every bit of the learning experience.

A major highlight during my stay was the two-day group retreat at TUM Academy Center Raitenhaslach in April 2025. We travelled by bus from Freising, we lodged at Hotel Burgblink in Austria, since it was very close to the retreat centre, this gave me the opportunity to visit



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Austria during my stay. We also visited the Burghausen castle, which is longest castle complex in the world (about 1051 m), We were also treated to a traditional German dinner and it formed a part of the cultural experience during my stay.



Plates 17 – 20: Visit to Burghausen Castle





Plate 21: With the two masters studentsPlate22: AtTUMAcademyCenter(Shubh and Chetan)Raitenhaslach

Conclusion and Acknowledgements

My career exploration stay will remain a memorable experience for me, and the skills, knowledge and expertise I have acquired will be put into use in my future research. I am deeply grateful to my host supervisor, Prof. Mohsen Zare, for sharing this incredible opportunity with me and supporting me throughout the experience. My sincere appreciation also goes to Prof. John Derera and the entrie team at the International Institute of Tropical Agriculture, Ibadan, Nigeria for facilitating the procurement of the seeds used during the research. I am especially thankful to my family for their unwavering support, and to ATSAF e.V. for the generous funding that made this stay possible. Finally, I would like to extend my heartfelt appreciation all staff of the ATSAF Academy, especially to Beatrice Breuer and Sabine Baumgartner, for their dedicated support and assistance before and during my stay.