



Applications of Unmanned Aerial Vehicles for Detecting Drought Tolerance in Spring Wheat Varieties

Lindsey Stachofsky

Phenomics Big Data Management

USDA-NIFA REEU Project

University of Idaho

Mentor: Dr. Pumphrey



WASHINGTON STATE
UNIVERSITY



University
of Idaho



Background

Precision agriculture

Drought and long-term crop productivity

Genetic variation in spring wheat trials



Methods



Drone Imaging

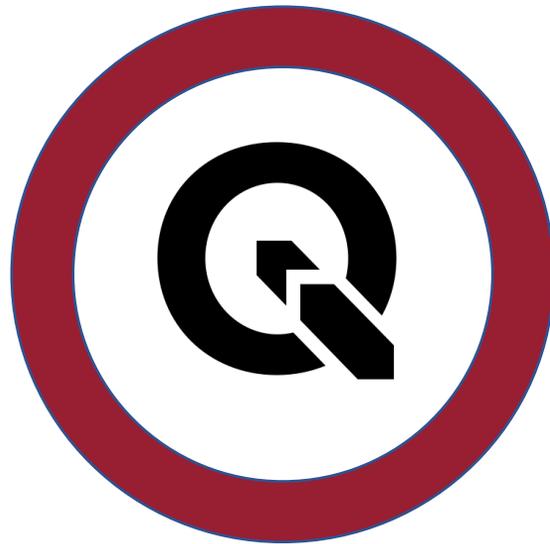
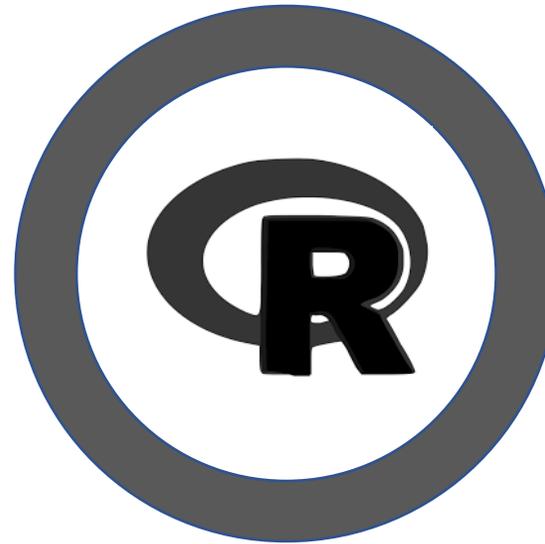


Image Processing



Spectral Indices Calculation



Statistical Analysis



Data Collection

- Variety Trial Sites
 - Lind, Plaza, Palouse, Moses Lake
 - Lind 2020
- 2021 Rainfall (March-May)
 - Lind: 1.46"
 - 2020: 3.29"
 - Plaza: 2.58"
 - Palouse: 5.71"
 - Moses Lake: Irrigated



Drone: Inspire 2

Eight Band Sensor:
RGB (380-780nm), RE1, RE2,
NIR (780-2500nm), 900 nm, 975 nm



Indices Calculated

- NDVI (Normalized Difference Vegetation Index)
 - Trait Measured: Chlorophyll Content
 - Equation: $NDVI = \frac{NIR - RED}{NIR + RED}$
- NWI (Normalized Water Index)
 - Trait Measured: Water Content
 - Equations: $NWI 1 = \frac{975 - 900}{975 + 900}$
 $NWI 2 = \frac{975 - NIR}{975 + NIR}$

HEALTHY
VEGETATION REFLECTANCE

50% NIR 8% RED



NDVI = 0.72

STRESSED
VEGETATION REFLECTANCE

40% NIR 30% RED



NDVI = 0.14

<https://www.agricolus.com/en/indici-vegetazione-ndvi-ndmi-istruzioni-luso/>



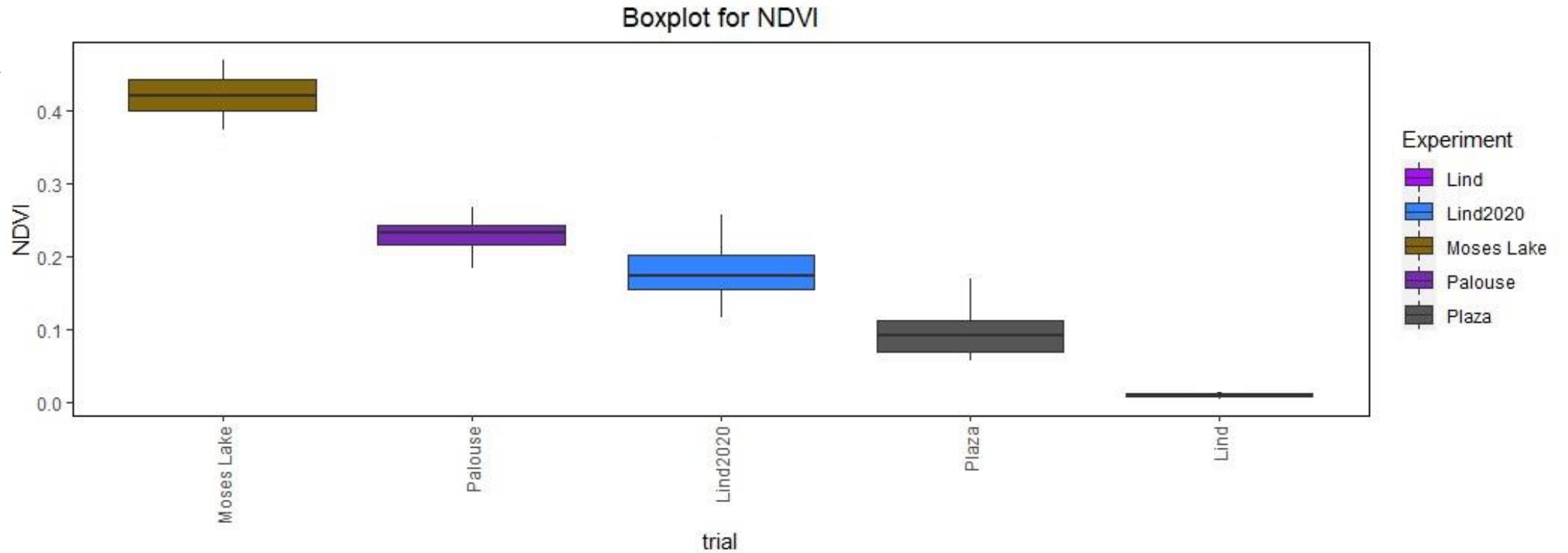
Statistical Software

- StatGen GxE (Genotype by Environment Analysis)
 - <https://cran.r-project.org/web/packages/statgenGxE/readme/README.html>
- StatGen STA (Single Trial Analysis of Field Trials)
 - <https://rdrr.io/cran/statgenSTA/>
- Metan (Multi Environment Trait Analysis)
 - <https://tiagoolivoto.github.io/metan/>





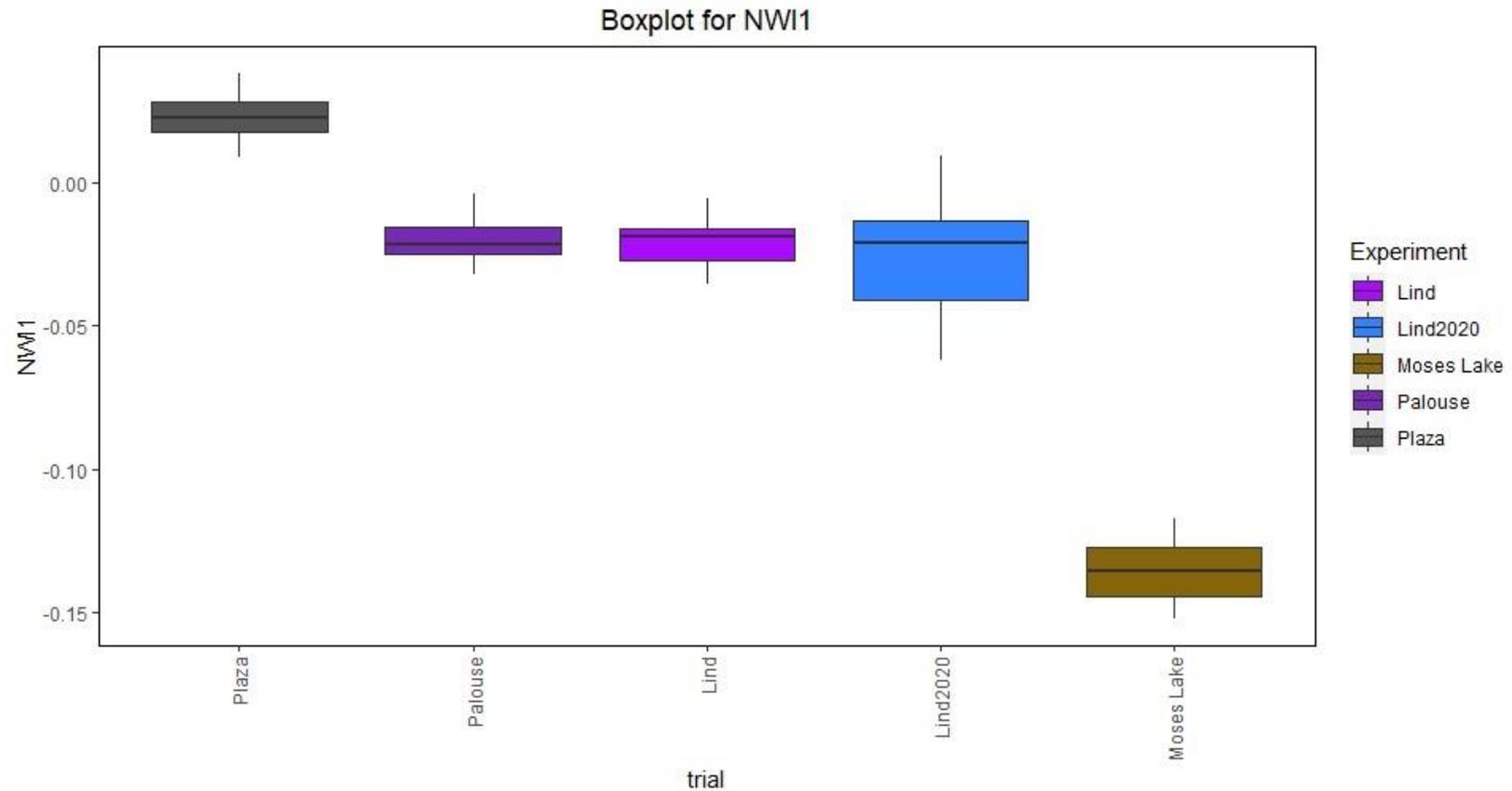
NDVI values increase with rainfall





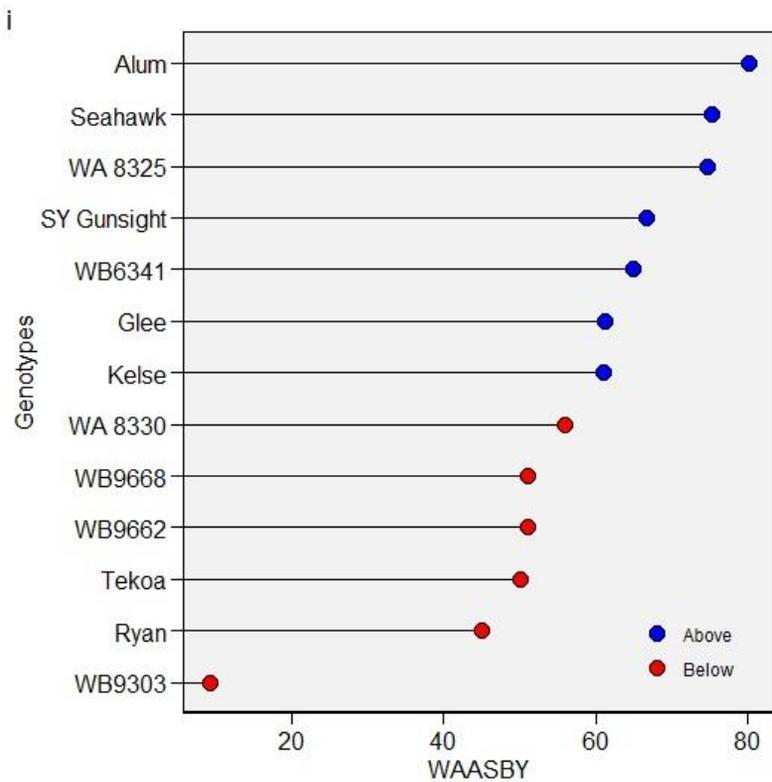
NWI partially correlates to rainfall

Water
Content

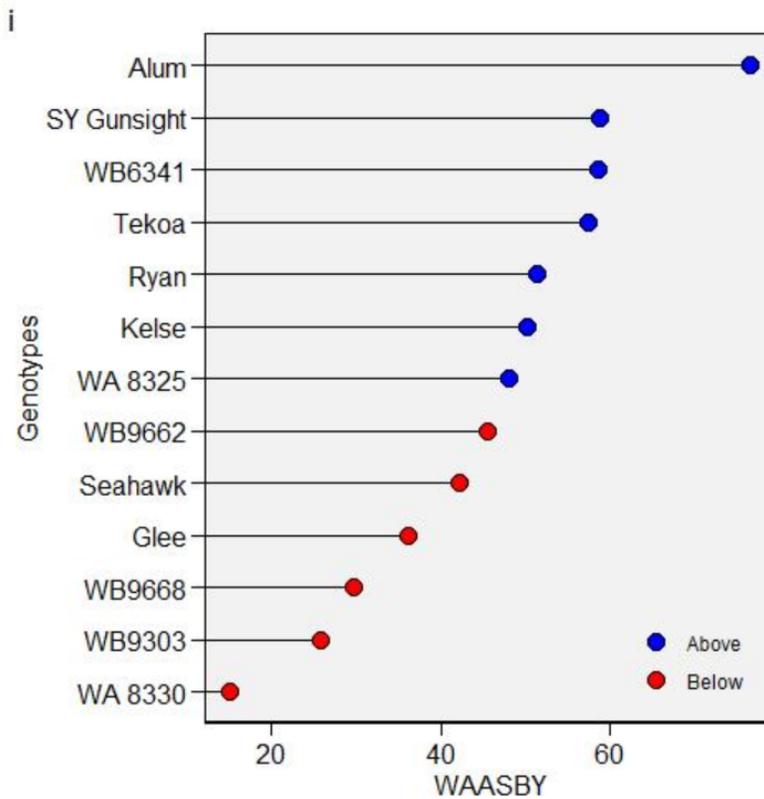




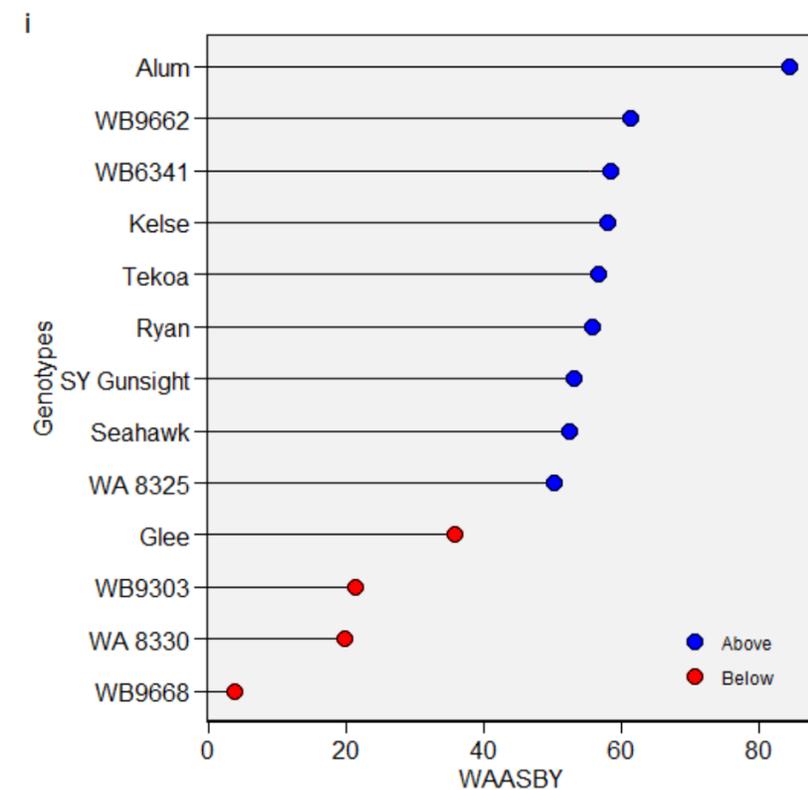
Alum Variety Ranked 1st With Performance and Stability Equally Weighted



NDVI



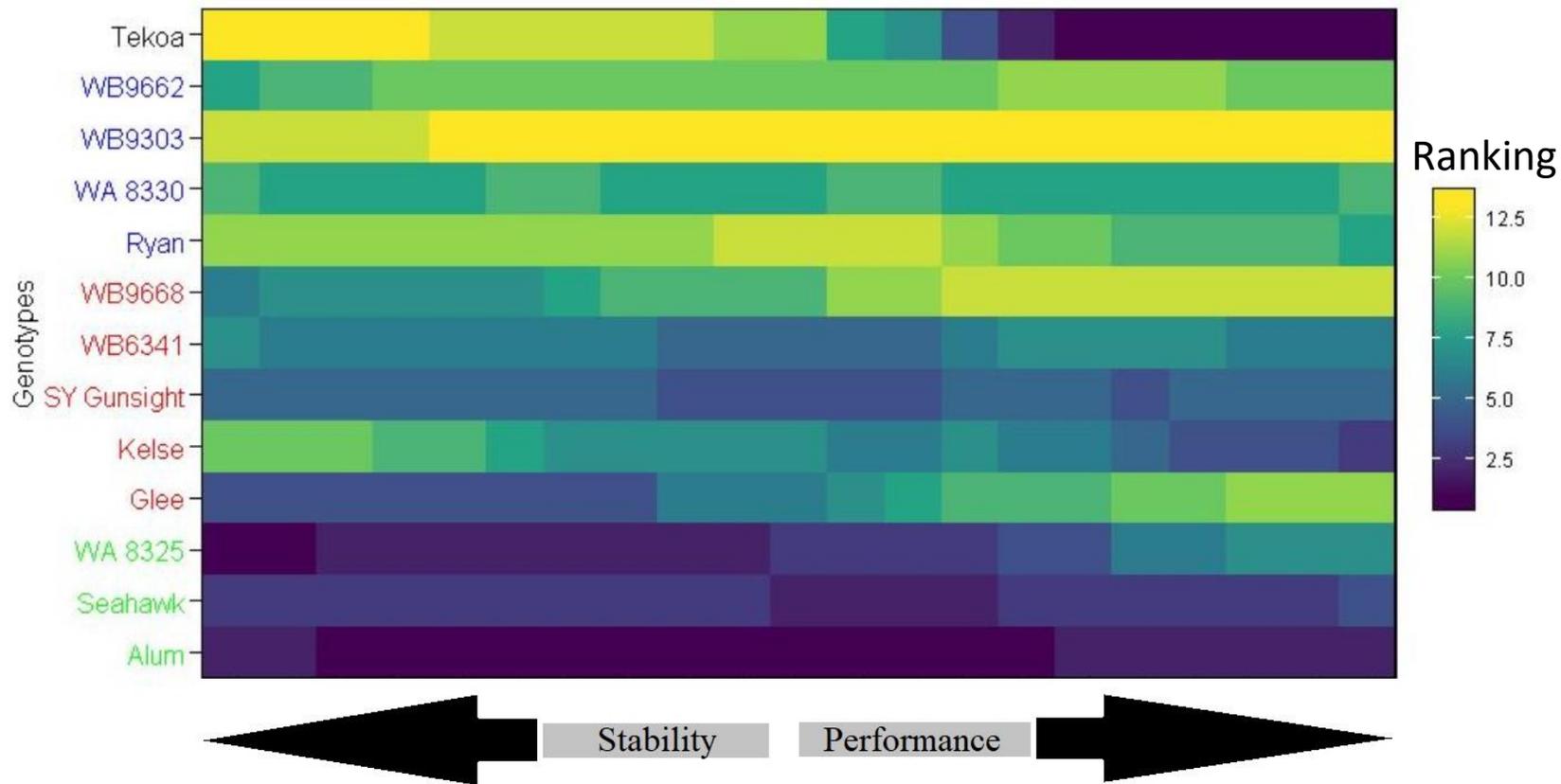
NWI1



NWI2



Ranked Performance of NDVI Changes With Preferability of Stability or Performance





Discussion & Future Work

- Precipitation Impact
 - NDVI
 - NWI
- Predictions
- Analyze Yield Data
- Continued Testing





Acknowledgements

- Dr. Mike Pumphrey
- Dr. Sindhuja Sankaran
- Peter Schmuker
- Andrew Herr



Summer 2021

FACT: Research Experience for Undergraduates on Phenomics Big Data Management



United States Department of Agriculture
National Institute of Food and Agriculture

Research and Extension Experiences for Undergraduates (REEU)
Project: 1021788



References

1. Antognelli Agronoma, S. (2021). *NDVI and NDMI vegetation Indices: Instructions for use*. Agricolus. <https://www.agricolus.com/en/indici-vegetazione-ndvi-ndmi-istruzioni-luso/>.
2. Barnhart, I.; Chauhaudri, S.; Pandian, B.A.; Prasad, P.V.; Ciampitti, I.A.; Jugulam, M. (2020). *Use of High Resolution Unmanned Aerial Systems Imagery and Machine Learning to Evaluate Grain Sorghum Tolerance to Mesotrione*. Preprints 2020, 2020100022 (doi: 10.20944/preprints202010.0022.v1).
3. Olivoto, T., and Lúcio, A.D. (2020). metan: an R package for multi-environment trial analysis. *Methods Ecol Evol.* 11:783-789 doi:10.1111/2041-210X.13384
4. van Rossum, B.-J., Boer, M., van Eeuwijk, F., Bustos-Korts, D., Millet, E. J., Paulo, J., Verouden, M., Kruijer, W., Wehrens, R., & Zheng, C. (2021, May 25). *statgenSTA: Single trial Analysis (STA) of field Trials*. rdrv.io. <https://rdrv.io/cran/statgenSTA/>.
5. van Rossum, B.-J., van Eeuwijk, F., Boer, M., Malosetti, M., Bustos-Korts, D., Verouden, M., Paulo, J., Millet, E. J., Zheng, C., Wehrens, R., & Kruijer, W. (2021). *statgenGxE: Genotype by Environment Analysis*. <https://cran.r-project.org/web/packages/statgenGxE/readme/README.html>.



Thank You

Questions?