Boosting drought tolerance in key cereals in the era of climate change

BOOSTER
BOOSTING DROUGHT TOLERANCE IN KEY CEREALS IN THE ERA OF CLIMATE CHANGE

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Introduction and project's objectives

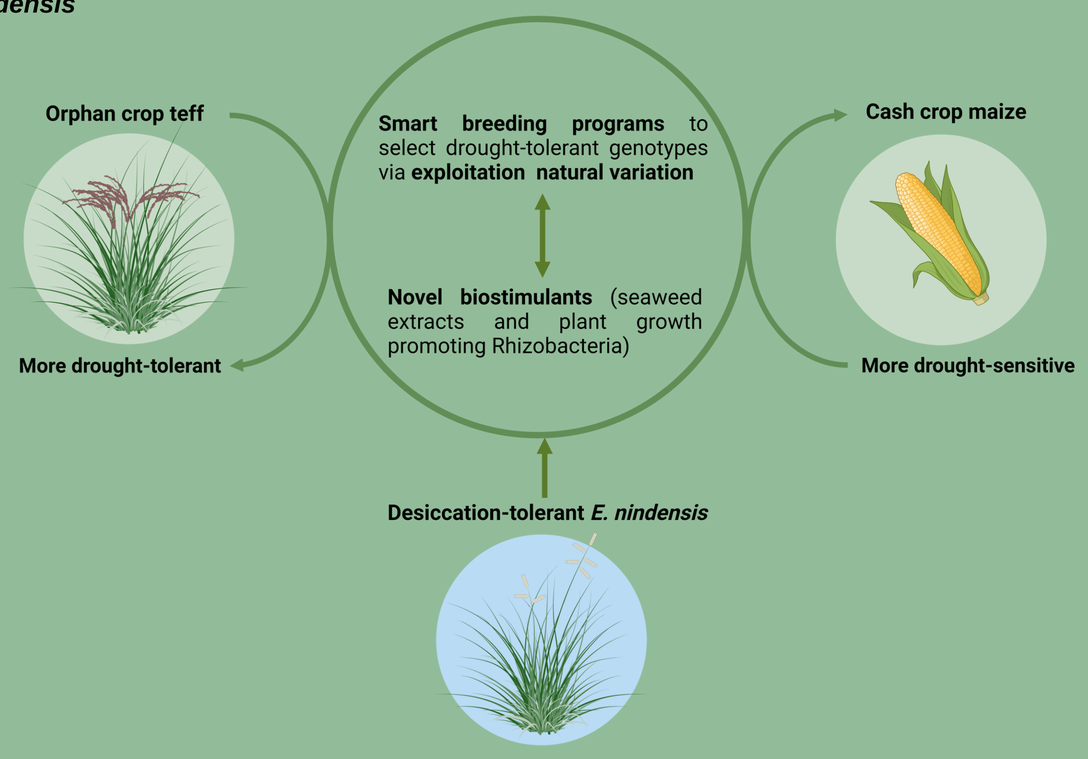
Drought due to climate change has a severe impact on agriculture, requiring measures to secure yield stability under water shortage conditions. The project entitled: "Boosting drought tolerance in key cereals in the era of climate change" – Acronym: **BOOSTER** - has the aim to **create climate resilient** and **drought tolerant cereals**.

- **Genome-wide identification of maize and teff cis-regulatory elements (CREs) and genes associated with drought tolerance.**
- **Comparative genomics of drought CREs and genes in three different grasses and validation of maize and teff drought CREs genome-wide data.**
- **Development and characterization of new seaweed extract (SWE) and microbial biostimulants for improving maize and teff drought tolerance.**
- **Production of the best performing SWE and microbial biostimulants and evaluation of their performance in improving maize and teff drought tolerance through field trials.**
- **Project dissemination, exploitation, and communication**

1 Two cereal crops and one desiccation tolerant plant

Maize i) crop of **global importance**; ii) drought is a leading cause of yield loss; iii) important **model system** with numerous genetic and genomic resources; iv) feedstock for the production of various products used **for human consumption, livestock feed, and biofuel**. This project will focus on the European maize germplasm.

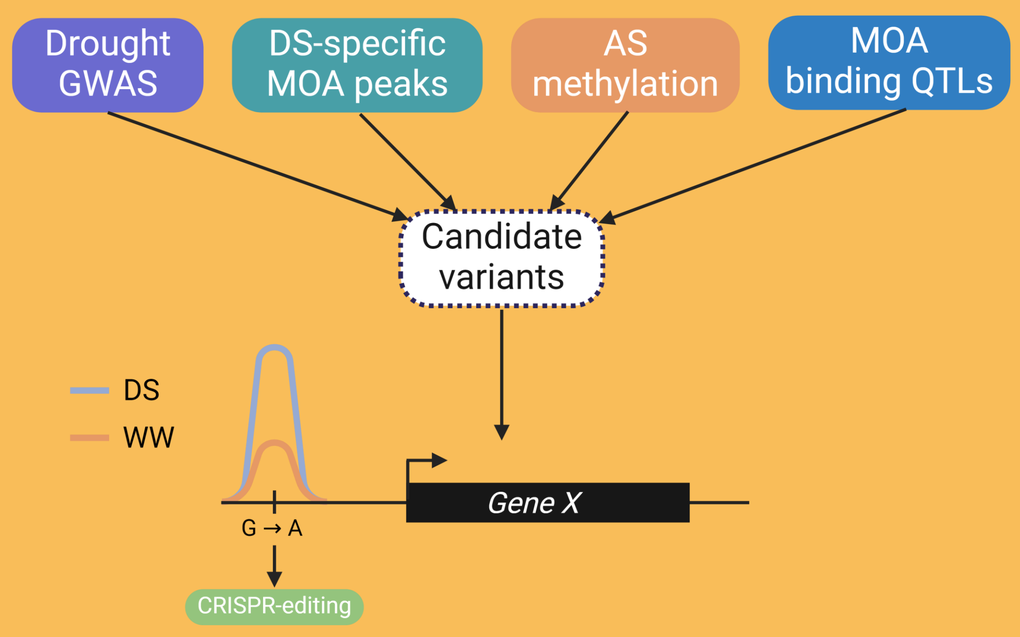
Teff: i) **major food and nutrition security crop** in the Horn of Africa; ii) **superfood** (gluten free, fiber-rich, outstanding nutritional properties); iii) belongs to the grass subfamily *Chloridoideae*, containing grasses evolved to **survive extreme environments**; iv) **relatively drought tolerant**, but still affected by prolonged drought; v) closely related to the Southern African desiccation-tolerant grass ***Eragrostis nindensis***



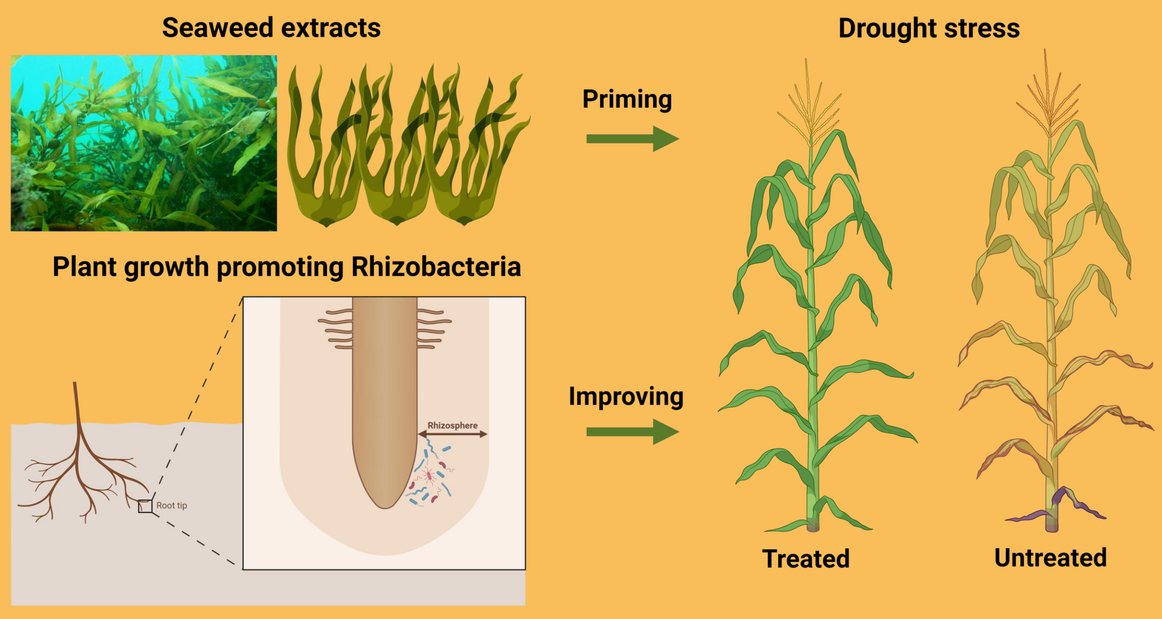
High quality genome sequences for maize genotypes & teff and *E. nindensis* are available. The major objective of BOOSTER is to implement strategies for **improving drought tolerance in European maize and Ethiopian teff**. The aim is to explore the potential for transferring **genotype- and species-specific drought responsive features** from an orphan cereal like teff to a cash crop like maize.

2 Two synergistic strategies

Natural genetic variation within CRE in response to drought conditions (MOA/mRNA-seq)



- **MNase-defined cistrome-Occupancy Analysis (MOA-seq):** allows a high-resolution (ca 30 bp) genome-wide **identification of putative TF-binding sites**.
- Coupled to **mRNA-seq**, **quantitative variations of TFs binding** in the CREs can be detected in different genotypes under well-watered (WW) and drought stress (DS) conditions.
- Identified drought- responsive CREs can be **linked to the expression of key drought tolerant genes**.
- Integration of **MOA-seq results** in **response to drought** with available drought **GWAS** to further improve the identification.
- Data validation is performed by **genome editing** and other methods to **modify the putative cis-elements and/or to knockout genes they regulate**.



- **Seaweed extracts** are efficiently applied before the occurrence of the stress and induce molecular priming by modulating the response to oxidative stresses.
- **Plant growth promoting Rhizobacteria:** candidates will be identified by i) collecting soils that have a history of long periods of drought + plant genotypes adapted to drought (e. g. *E. nindensis*) and ii) colonizing root endophytes and rhizosphere to alter root exudates under drought stress.
- **Mode of action:** BOOSTER will investigate the mode of action of selected seaweed extracts and plant growth promoting Rhizobacteria to improve the development of a scientifically based biostimulant formulation.
- **Field trials:** will be performed in distinct European locations and in drought prone areas of Ethiopia, using selected biostimulants for their validation in a relevant environment.

3 Project impacts

Result KPIs	Outcome KPIs
WP1-4	Typology: scientific
- 12 publications in mid-high tier IF journals - Training of ca. 11 post-docs & 3 PhD students	- Transfer of MOA/mRNA-seq technique to maize African germplasm or any other crop - Use of the technique for improving quantitative traits other than drought tolerance - Maize/teff leaf blade CREs maps for eQTLs-based studies
	Potential transfer of drought genotype and species-specific drought responsive features from *E. nindensis*/teff to maize through new breeding technologies
	≥10 trained young researchers hired
WP1, 2 & 5	Typology: economic/technological
List of maize & teff genetic variants within CREs & genes functionally associated with drought tolerance	Production of 1-3 maize & teff drought-tolerant genotypes through breeding programs
	First release of drought-tolerant varieties: reduction of yield loss and saving ca. €24mn/year & €15mn/year for maize & teff production, respectively
	Maize drought-tolerant genotypes can save ca. 1.75-4 m^3/year of water required for irrigation of maize in EU
WP3, 4 & 5	Typology: economic/technological
Patents for up to 4 maize & 4 teff field trials validated seaweed extracts and microbial biostimulants	- Commercialization and diffusion of 4 maize & 4 teff biostimulants - Revenue spanning from € 20 mn/year to 80 mn/year
	Transferability of seaweed extracts and microbial biostimulants for improving drought tolerance in other crops
	Biostimulants: reduction of yield loss due to drought of ca. 0.33%, saving about €8mn/year and €2mn/year for maize and teff production, respectively
	Maize biostimulants can save ca. 0.58-1.33 million m^3/year of water required for irrigation
WP3, 4 & 5	Typology: social
Patents for up to 4 maize & 4 teff field trials validated seaweed extracts and microbial biostimulants	- Commercialization of 4 maize & 4 teff biostimulants - Hiring of minimum 10 agronomists working on seaweed extract biostimulants
WP5	Typology: social
Targeting ca. 25.000 citizens/students/professionals in the 10 consortium countries	Increased public knowledge and awareness about bio-based technologies for ca. 50.000 citizens/students/professionals in all EU27 & additional African and Associated countries (see section 2.2 for methods and details)

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