DARkWIN PROJECT

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NEW APPROACH TO PLANT BREEDING

PROBLEM: Securing food production against climate change

- Food security is threatened by climate change, with heat and drought being major stressors affecting crops and plant-pollinator interactions.
- Phenotyping platforms face challenges in accurately predicting genotype-to-phenotype relationships, particularly in quantifying flower traits.
- Flowers are becoming increasingly relevant in sensing stress, as their chemical composition and production of pollen and nectar change in response to heat and drought.
- Low-resilient plants show reduced transport of photoassimilates from leaves to flowers, making flowers better indicators of plant well-being than leaves.
- Pollinators rely on the food resources provided by flowers, highlighting the importance of understanding flower responses to stress for food security.

DARkWIN SOLUTION: Is the turn of Bee to decide

- DARkWIN proposes a method to track and rank pollinator preferences for flowers of a tomato mapping population exposed to heat and drought.
- A pollinator-assisted selection and phenotyping platform will be developed for automated quantification of Genotype x Pollinator x Environment interactions through a bumblebee geo-positioning system.
- The platform will be validated by a multi-omics dataset of unprecedented dimensions in a mapping population of tomato, including floral metabolic, transcriptomic, and ionomic traits, as well as mapping candidate genes.
- This approach aims to change the current paradigm of plant phenotyping and find new paths for crop breeding assisted by ecological decisions.
- DARkWIN will deliver tomato F1 pre-commercial varieties based on the natural biological process of pollinator driven selection under climate change conditions.

Project duration

The DARkWIN project launches the 1st January 2023 and will last for 42 months.

An interdisciplinary consortium

We are a multidisciplinary consortium of 8 partners united with the objective of bringing to market the DARkWIN concept.

TRL Technological maturity achieved and attainable

The state of technological maturity is at Level 2 and aims to complete during the project Level 3 (Quantification of pollinators preference) and Level 4 (Establishment of the geopositioning prototype and experimental validation).

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OBJECTIVE

Our research proposed objectives are fully aligned with the priority objectives of the EC 8th Environment Action Programme, CAP and the EU Taxonomy Regulation.

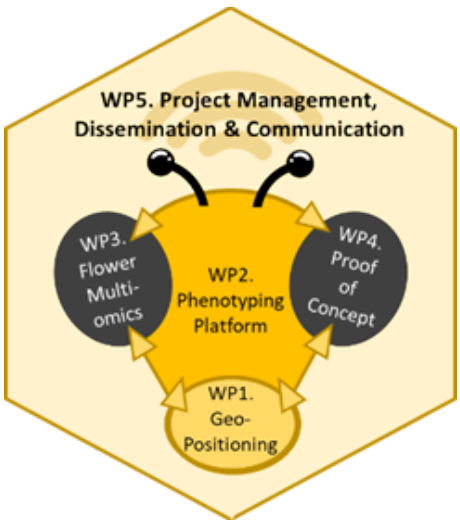
Our aim is to develop a unique phenotyping and selection platform for pollinator-assisted breeding. DARkWIN is based on a geo-positioning device specifically designed for bumblebees (*Bombus terrestris*), that will quantify pollinator preference in a tomato mapping population under combined water x heat stress, to mimic a climate change scenario.

INTERDISCIPLINARITY

DARkWIN is a project aimed at revolutionizing plant phenotyping, selection, and breeding through a multidisciplinary approach to create a unique platform for pollinator-assisted plant phenotyping and natural selection under environmental pressure for breeding decisions. To achieve this, the project integrates transversal disciplines and several areas of expertise, including:

- Crop physiology
- Ecology and entomology
- Electronics and robotics
- Bioinformatics
- Data management
- Greenhouse technology
- Ionomics, metabolomics and transcriptomics
- Plant genetics
- Plant breeding

WORK PLANNING



The DARkWIN project launches the 1st January 2023 and will last for 42 months. It is structured in 4 technical Work Packages (WPs).

CSIC, DORIANE and NOVAGRIC will develop the insect geo-positioning device in WP1, the core component that will be integrated with other plant-growth and data capture related elements to build the phenotyping platform in WP2. CSIC, MAX PLANCK, DORIANE, NOVAGRIC will use that platform in WP3 to establish the scientific basis of the concept by phenotyping a tomato mapping population generating multi-omic datasets for breeding purposes based on insect decisions. Breeding lines provided by UNIGENIA and selected in WP3 will feed WP4 for proofing DARkWIN concept by producing pre-commercial F1 hybrids. CSIC will lead all partners in management, communication and dissemination activities in WP5.

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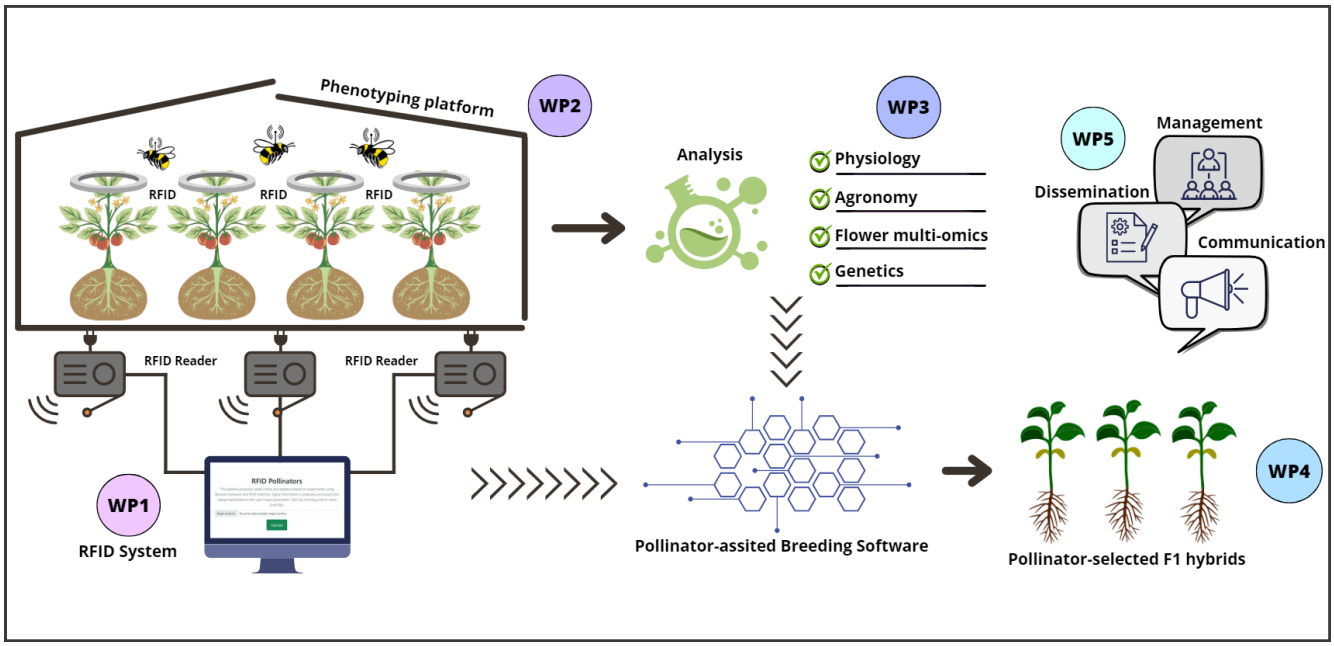
WORK SCHEME



WP1

Led by CSIC-CAR

Insect Geo-positioning device

A RFID geo-positioning system will be configured and validated for the accurate detection and quantification of the plant x pollinator interactions at the single plant level, and optimized to minimize the impact on bumblebee's behavior. This technology will be scaled to the phenotyping platform in WP2.

WP2

Led by NOVAGRIC

Pollinator assisted phenotyping platform under combined stress

Design, construction, and compartmentation of a phenotyping platform with a capacity to grow up to 1,000 tomato plants for the complete cycle at optimal planting density to secure individual and automated phenotyping by the pollinator. The platform will integrate a versatile environmental and irrigation control system and the insect geo-positioning device connected to a data acquisition, notation, and management system integrated into pollinator-assisted breeding software.

WP3

Led by CSIC-CBGP

Nutritional, metabolomics, transcriptomics, and genetics of GxP under climate change scenario

A tomato mapping population originating from Solanum lycopersicum x Solanum pimpinellifoliumwill be phenotyped at the platform developed in WP2 based on agronomical/physiological/pollinator-related traits under optimal and climate change scenarios. The generated information will serve for the identification of morphological, nutritional, metabolic, transcriptomic, and hormonal traits influencing pollinator's choices; the identification of QTLs and candidate genes of flower's traits influencing resilience and pollinator's foraging decisions; and all the Data will be integrated into a pollinator-assisted breeding software. The tomato population will be scored and promising lines selected for WP4.

WP4

Led by UNIGENIA

Proof of concept: pollinator selected F1 hybrids

Pollinator and breeder-based selection of a collection of tomato breeding and elite parent lines under optimal and combined water x temperature stress will be carried out. The selected lines will be used for the generation of unprecedented set of F1 pre-varieties based on pollinator selection. Pollinator- and human-selected F1 hybrids will subjected to phenotyping for pollinator's preference under climate change scenario. Future new F1 varieties based on natural selection of pollinators will be protected.

WP5

Led by CSIC-CEBAS

Project Management, Dissemination, and Communication

Coordination, in an executive, technical and scientific way, all project's tasks, by implementing all legal, technical, gender and financial aspects, and raise awareness of benefits of DARkWIN platform in scientific and industrial communities.

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