Pollinator-assisted plant natural selection and breeding under climate change pressure

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CONCEPT

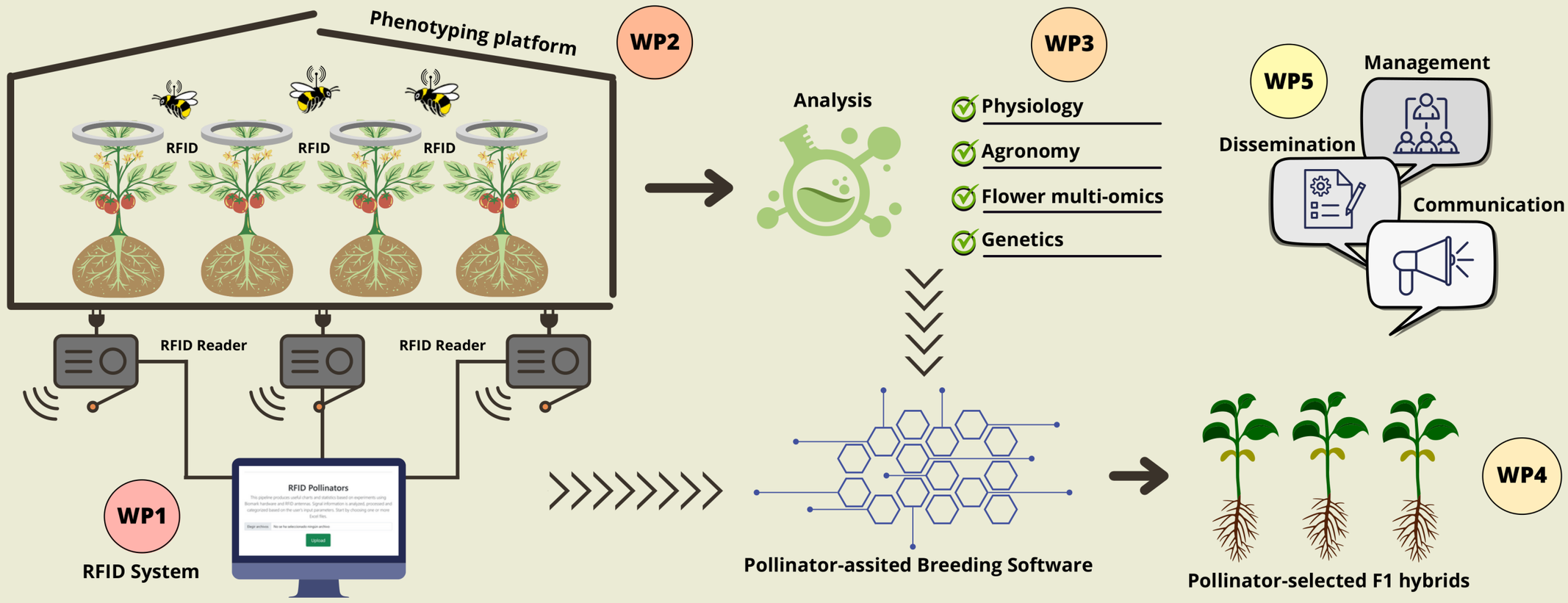
DARkWIN's concept integrates both the classical human eye selecting the healthiest genotypes under stressful environments (where darker/greener plants are usually selected: **DARk**-plants win), and the dar**WIN**ian pollinator bee vision where the most rewarding flowers from the healthiest plants will be naturally selected. DARkWIN's radical new vision will use "Living IoT" to quantify the optimization degree of source-sink relationships through plant lifespan by analysing Genotype x Pollinator x Environment (GxPxE) interaction.

OBJECTIVES

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. The specific technical objectives are:

- Developing a new geo-positioning device for plant-pollinator interactions.
- Creating the first automated platform to study climate-resilient floral traits.
- Developing a pioneered pollinator-assisted plant breeding technique.
- Analysing phenotyping for crop quality.
- Establishing an unprecedented multi-omics database on pollinator-driven natural selection in climate change-affected tomatoes.
- Modelling pollinator foraging and plant-pollinator networks.
- Developing new tomato F1 hybrids under combined drought-high temperature stress through pollinator-driven selection.

WORK PLAN



WP1 Insect Geo-positioning device
Led by CSIC-CAR

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 Pollinator assisted phenotyping platform under combined stress
Led by NOVAGRIC

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 Nutritional, metabolomics, transcriptomics, and genetics of GxP under climate change scenario
Led by CSIC-CBGP

A tomato mapping population originating from *Solanum lycopersicum* x *Solanum pimpinellifolium* will 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 Proof of concept: pollinator selected F1 hybrids
Led by UNIGENIA

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 be 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 Project Management, Dissemination, and Communication
Led by CSIC-CEBAS

Coordination, in an executive, technical and scientific way, of 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.

Consortium

European Innovation Council

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Designed in Murcia by Juan José Guerrero (CEBAS-CSIC)