An alliance for the protection of plants: The Thematic Group "Plant Health" DISTAL – UNIBO
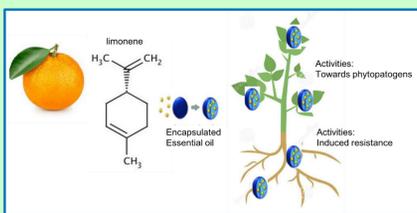
TG PLANT HEALTH

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## PLANT DISEASE CONTROL USING NATURAL SUBSTANCES

The need for environment protection and food quality maintenance are among the biggest challenges of this century. The main strategy to control plant diseases is based on the use of integrated methods, such as chemical treatments (i.e. pesticides) or biological control agents.

Among the latter, new emerging natural substances such as hydrolate (HY) and essential oils (EO) formulated through emulsion or encapsulation, are at the basis of promising strategies to find more eco-friendly control tools towards phytopathogens. Since the maintenance of plant growth and health has a direct impact on human welfare, in a traditional pesticide crop management system a hopeful transition to the use of an EO/HY combination should be promoted along with lowering the doses of synthetic pesticides.

## INNOVATIVE DIAGNOSTIC TECHNIQUES

Fast, sensitive and accurate detection of plant pathogens is of most importance in plant health, not only for management purposes, but also for improved surveillance of emerging pathogens and unwanted introductions. Traditional and variant polymerase chain reaction (PCR) based assays, isothermal and post amplification tools, hybridization techniques, and next-generation sequencing (NGS) approaches are well-known for phytopathogen detection.

We are developing and applying innovative techniques, for early detection of fungi, bacteria, viruses and viroids, based on qPCR, Digital PCR and metagenomic analysis. In particular, DISTAL facilities include Digital Droplet PCR and MinION devices.
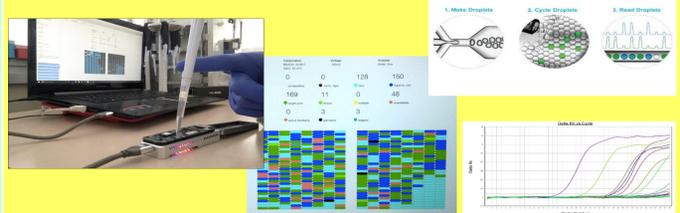
FUNCTIONAL BIODIVERSITY FOR PEST CONTROL AND POLLINATION

In agricultural environments several ecosystem services essential for crop production (e.g. pollination and pest control) rely on insect diversity. However, insects are declining worldwide with likely negative consequences on food stability. Nature-based solutions, including ecological intensification, have been proved to be effective in inverting this trend. Suitable strategies to enhance function biodiversity (e.g. pollinators, natural enemies) can mitigate the impact of human activities and increase the resilience of the agro-ecosystems.
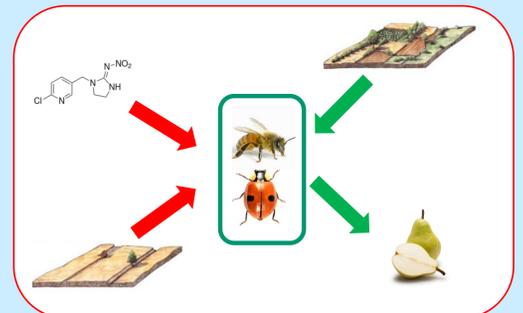
BIOINOCULANTS FOR A SUSTAINABLE AGRICULTURE

The model of agricultural production currently used will not be able to sustain the expected worldwide population growth. Moreover, a large part of agricultural food production is intensive, conflicting with the public demand for increased environmental sustainability. Plant Growth Promoting Microorganisms (PGPMs) are known as beneficial microbes able to improve plant's growth and health by phytohormones production, nutrients mobilization and systemic resistance induction.

PGPMs inoculation for plant health improvement have been largely explored. However, there is still a need for advanced comprehensive research on the effects of probiotics synergic effects, both from the molecular and the physiological points of view. In addition, further studies on their effects on plant microbiota (including symbiotic microorganisms and endophytes) should be expected.
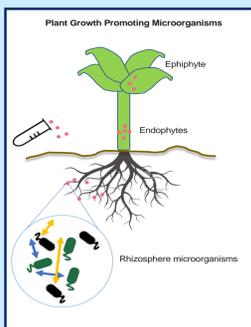
OUR JOINT EFFORT TO PROMOTE THE HEALTH OF THE PLANTS INVOLVES THE DESIGN OF STRATEGIES TO:

CONTROL PLANT PARASITES

ENHANCE NEW AGRONOMIC PRACTICES AND PLANT NUTRITION APPROACHES TO REDUCE THE IMPACT ON ECOSYSTEMS

### SELECT NEW VARIETIES RESISTANT TO ABIOTIC AND BIOTIC STRESSES

MANAGE THE USE OF PESTICIDES, CULTIVARS AND FERTILIZERS FOR A MORE SUSTAINABLE AND CLIMATE-RESILIENT AGRICULTURE

ECOTOXICOLOGY OF BENEFICIAL INSECTS

Pesticides are routinely used to reduce pest pressures on crops, yet their wide use poses a strong risk to beneficial insects. Although, before being authorized, pesticides undergo a risk assessment process, agro-chemical pollution has been identified as one of the main factors associated with insect decline. New and updated ecotoxicological studies are important to identify the real impact of pesticides in the field considering the interaction with other stressors and the complexity of the environment.
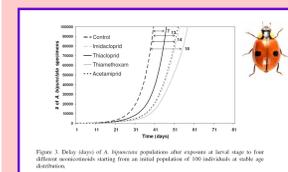
Lanzoni et al. (2012) IOBC Bull
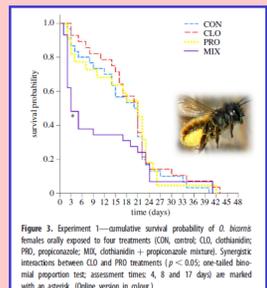
Sgolastra *et al.* (2018) *Proc Roy Soc B*

## AGRO-ECOLOGY AND MANAGEMENT OF THE AGRICULTURAL LANDSCAPE

Urban green infrastructures (UGIs) currently play a prominent role in landscape management. Cities benefitting from effective and healthy UGIs can count on positive impacts at local scale, easing disruptive phenomena linked to ongoing climate change and natural habitat fragmentation. Green elements composing UGIs are exposed to stressful conditions that make them more susceptible to biotic agents. Since the regulations concerning the use of pesticides and fungicides in urban areas are even more restrictive than in agriculture, prevention could be an effective way to address the issue. Increasing biodiversity would be very important at population level, but single plant fitness plays a key role in fighting pathogens.

Ongoing studies focus on "plant-urban environment" relations to understand what kind of integrated systems perform better, limiting stresses and promoting synergistic effects through different combinations of woody and herbaceous species. Physiological performances are being assessed both for healthy and affected plants in order to estimate the replacement needed to restore a regular provision of ecosystem services.

GENOMICS-ASSISTED BREEDING FOR RESISTANCE TO STRESS

The selection of healthy crops more resilient to abiotic/biotic stresses is crucial to ensure food security, its sustainability and the reduction of the environmental footprint of primary production. Two important prerequisites to implement genomics-assisted breeding are an accurate phenotyping (1) and access to germplasm collections with novel allelic variants at the genes and QTL governing stress resistance. In durum wheat – the donor of the A and B genomes of bread wheat (AABBDD) – the **G**lobal *D*urum wheat **P**anel (**GDP**) and the **T**etraploid wheat **G**lobal **C**ollection (**TGC**) capture large allelic diversity worldwide (2,3). The GDP and TGC are used to map and clone major QTL for resistance to drought (4), heat, SBCMV (5), leaf rust (6) and fusarium head blight. Marker-assisted selection (MAS) is being implemented in collaboration with CIMMYT and seed companies. A major effort is devoted to dissect the root QTLome (7-9) for its role in governing resistance to drought stress.

1. Tuberosa (2012). *Front Physiol* 3, 347
2. Maccaferri et al (2019). *Nat Gen* 51
3. Mazzucotelli et al (2020). *Front Pl Sci* 11
4. Maccaferri et al (2011). *JXB* 62, 409
5. Maccaferri et al (2011). *TAG* 123, 527
6. Liu et al (2017). *Front Pl Sci* 8, 774
7. Maccaferri et al (2016). *JXB* 67, 1161
8. Alemu et al. (2021). *BMC Genomics* 22
9. Kirschner et al (2021). *PNAS* 118, 35

GDP and *TGC* for allele mining and MAS.
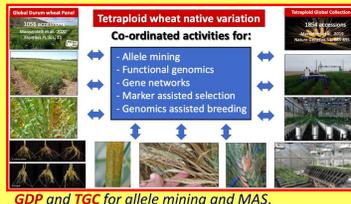
ANALYSIS OF PUBLIC GOODS AND ENVIRONMENTAL ISSUES

The incentives for farmers to uptake environmentally friendly practices and to improve the current agri-environmental schemes of the Common Agricultural Policy (CAP) are crucial in the implementation of environmental policies. In the CONSOLE project four ways to improve agri-environmental contracts are investigated: 1) collective approaches, 2) result-based schemes, 3) land tenure contracts, 4) value chain arrangements.

GUIDELINES FOR THE STORAGE OF OLIVES AND HEMP SEEDS TO OBTAIN HIGH QUALITY OILS

The deterioration of the seed causes hydrolytic and/or oxidative rancidity (low quality oil).

Bad conservation of seeds and olives determines sensory and nutritional degradations.

DEFINITION OF THE BEST PRACTICES FOR THE STORAGE

RESEARCH PROJECTS

INTERNATIONAL

CEREALMED – Enhancing diversity in Mediterranean cereal farming systems - PRIMA 2020-23
CONSOLE – Analysis of improved agri-environmental contracts - H2020 2019-22
INNOVAR – Next generation variety testing for improved cropping on European farmland - H2020 2019-24
LIFE4POLLINATORS – Involving people to protect wild bees and other pollinators in the Mediterranean - LIFE 2019-23
LIFT – Analysis of low-input farming - H2020 2018-22
MED-BERRY – Strategies to protect strawberry crop in the Mediterranean - PRIMA 2019-22
PHYFOR – Diversity of phytoplasmas detected in European forests - EUPRESCO 2017-23
ROOTY – A root ideotype toolbox to support improved wheat yields - IWYP 2018 – 21
SHOWCASE – Functional biodiversity for agricultural activity management - H2020 2020-25
TROPICSAFE – Insect-borne prokaryote-associated diseases in tropical/subtropical perennial crops - H2020 2017-22

NATIONAL/REGIONAL

DIBIO – Agroecological approach to reduce extra-business inputs to organic crop protection - MIPAAF 2019-22
APSOV 2020-23 - Genes for disease resistance to implement marker-assisted selection in durum and bread wheat
MAC - Pear brown spot: insights on causal agents, disease control in the climate change scenario - PSR 2020-22
Municipality of Vignola 2020-23 - Management of urban green infrastructure: analysis and monitoring
MIRALO – Maize inbred lines analysis to develop root efficient hybrids - Lombardia 2020-23
REFLUA – Swine wastewater and the environment: reduction of antibiotics and antibiotic resistance in wastewater to protect water and soil -PSR Lombardia 2019-21
RESISTI - New fast diagnosis systems and techniques with low eco-toxicological impact to contain resistance to pathogens, insects and weeds - PSR Emilia-Romagna 2020-22
SFR Emilia-Romagna - Analysis service on phytopathogens, controls of plant material for genetic correspondence

TG PLANT HEALTH

13 Research Units

32 Research Projects (last 5 years)

> 5 M € (last 5 years)

DISTAL 2018-2022 — DEPARTMENT OF EXCELLENCE MIUR

https://distal.unibo.it/en/research/research-groups/gti-plant-health