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CONCERT-Japan 3rd call
Food Crops and Biomass Production Technologies

"Phytopathogens: a good Opportunity to Improve crop yieldS and quality under changing Environmental conditions"
POISE

INTERIM REPORT

Project coordinator : Javier Pozueta, Spanish National Research Council (IAB-CSIC), Spain

The **main goals of this project** are to (i) improve yields and quality of two important crops (rice and tomato) subject to different stress conditions (e.g. high temperature and elevated CO_2 [HT/ECO_2] and drought) by treatment with compounds emitted by *Alternaria alternata*, and (ii) obtain insights into the fundamental mechanisms involved in the plant´s responses to compounds emitted by this fungal phytopathogen. **More specifically** we are investigating the effect of (i) exudates of *A. alternata* cultures on the transcriptome, proteome, metabolome, hormonome, and fruit yield and quality of a marketable tomato cultivar cultured under moderate and severe drought conditions, and (ii) mixtures of volatile compounds (VCs) emitted by *A. alternata* on the metabolome, hormonome, proteome and seed yield and quality of two marketable rice cultivars cultured under ambient and elevated CO_2 and temperature conditions.

Results:

- **Tomato plants** cultured under "severe" irrigation conditions developed typical drought symptoms. These plants showed lower photosynthetic capacity and were smaller than well-watered plants. This response was partly reverted by irrigation with fungal exudates. Yields of plants cultured under "moderate" and "severe" irrigation conditions were weaker than those of well-watered plants. Notably, fungal exudates enhanced yields of plants cultured under these conditions. Transcriptomic analyses showed that fungal exudates alter the expression of many genes in plants cultured under severe irrigation conditions. Metabolite and nutrient profiling's of leaves of tomato plants revealed that fungal exudates strongly improve the metabolic activity in severe drought conditions as reflected by an increase of almost all metabolites involved in primary and amino acid metabolisms. Thus, fungal exudate application positively influences the overall metabolism of tomato plants towards drought. Fungal exudates reduced the contents of active gibberellins. ABA contents in leaves of plants cultured under drought conditions were higher than in those of well-watered plants, and fungal exudates reduced them. Leaves of plants cultured under drought conditions accumulated lower levels of jasmonic acid than those of well-irrigated plants. Irrespective of the irrigation regime, fungal exudates enhanced jasmonic acid contents in leaves.
- In **rice**, VCs clearly increased the biomass, tiller and panicle numbers, plant height, and grain length and width compared to VC-non-treated controls. In VC-untreated plants, HT/ECO_2 conditions enhanced the rice growth and grain size, but symptoms of senescence and reduction in grain thickness were observed. Starch grains from seeds of VC-untreated plants showed many pores on the surface, and hence chalkiness under HT/ECO_2 conditions, but this appearance was suppressed by the VC treatment. Under normal and HT/ECO_2 conditions, VCs improved grain quality by decreasing the chalky grain and/or white core grains ratio. The photosynthetic rate increased with VCs application independently of the cultivars and growth condition. Transcriptomic analyses showed that (a) many genes are down-regulated by HT/ECO_2 and (b) fungal VCs promote global changes in gene expression. Hormone content analyses revealed that fungal VCs promote (a) the accumulation of active forms of plastidial CKs in leaves of plants cultured under ambient conditions, and (b) reduction of active CKs in leaves of plants cultured under HT/ECO_2 conditions.