【Workshop 2】Crop Production under Heat Stress

Extrapolating Crops to New Climatic Environments: Grey Zones of Knowledge and Research Needs for Modelling

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Any evaluation of climate change (CC) impacts on crop yields is based on quantitative extrapolation of knowledge and thus uses crop modelling as central tool. However, the validity, or robustness, of available models is limited even for currently observed ranges of environments, as parameter values still tend to be quite environment specific. Simulations for new environments thus constitute a major challenge. This is particularly true for rice, a species known for its great diversity of adaptations but also high level of vulnerability to environmental stresses.

As point of entry, 3 recent papers are discussed that each highlight a particular grey zone in our knowledge on crop response to climate in the field, and in particular thermal factors. One detects long term yield trends in rice experiments and struggles to explain them with climate, one questions the stability of cardinal temperatures governing plant development, and the last raises questions on the accuracy of our notion of maintenance respiration (Rm). The author then identifies major potential sources of error in extrapolative simulation of phenology and yield, (1) by failing to consider the conditions locally experienced by the plant organ concerned (micro climate) and (2) by making “established” but possibly wrong assumptions on process responses. Examples are given.

The paper terminates by asking what is “vigour” and “general adaptation” in terms of physiological plant-environment interaction, and if some of this is accessible to crop modelling. The question is particularly relevant in the CC context because breeding efforts and agronomic adaptation strategies increasingly consider shifts in ecosystem management (e.g., aerobic rice or water saving irrigation) and geographic/zonal shifts of cultivation. This involves new ideotype concepts, use of exotic germplasm sources and genetically engineered, modified plant behaviour (e.g., C4 rice project). Are models conceivable that not only extrapolate existing genotypes to changing environments, but also explore such adaptation for virtual varieties envisaged by research?