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EFFECTS OF CLIMATE CHANGES ON PLANT DISEASE UNDER SIMULATED CONDITIONS: CHALLENGES AND LIMITS

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Increases in CO_2 and temperatures are expected to induce complex effects on plant pathogens. Different approaches were used to study the effect of climate on plant diseases, including laboratory and/or field studies, as well as modeling-based assessments and simulations under phytotrons. During the last 10 years, the impact of climate changes such as increased CO_2 and temperature on pathogens affecting grapevine, basil, rocket, beet, lettuce, zucchini, radish, bean and geranium was assessed under phytotrons (Fig. 1).

Figure 1: Phytotrons used for experimental trials.

Plants were grown under different simulated climatic conditions:

(1) standard temperature (ranging from 18° to 22° C) and standard CO_2 concentration (400-450 ppm);

(2) standard temperature (ranging from 18° to 22° C) and elevated CO_2 concentration (800 ppm);

(3) average temperature (2°C higher than standard) and standard CO_2 concentration (400-450 ppm);

(4) average temperature (2°C higher than standard) and elevated CO_2 concentration (800 ppm);

(5) elevated temperature (4-6° C higher than standard) and standard CO_2 concentration (400-450 ppm);

(6) elevated temperature (4-6° C higher than standard) and elevated CO_2 concentration (800 ppm).

Disease index and physiological parameters (chlorophyll content, fluorescence) were assessed.

Table 1: Effect of increased CO_2 and temperature on plant pathogens under simulated environmental conditions in phytotrons.

Simulated climatic conditions	Downy mildew/ grape	Powdery mildew/ grape	Powdery mildew/ zucchini	Alternaria leaf spot/ rocket salad	Black spot/ basil	Phoma leaf spot/ garden beet	Downy mildew/ basil	Rust/ bean	Rust/ geranium	Fusarium wilt/ lettuce	Fusarum wilt/ rocket salad
Standard temperature and standard CO_2 (400 ppm) (control)	0*	0	0	0	0	0	0	0	0	0	0
Standard temperature and elevated CO_2 (800 ppm)	+**	0	0	+	+	+	+	+	+	0	0
Average temperature (+2°C) standard CO_2 (400 ppm)	n.°	n.	n.	n.	n.	n.	0	-***	+	n.	0
Average temperature (+2°C) and elevated CO_2 (800 ppm)	n.	n.	n.	n.	n.	n.	+	0	+	n.	+
Elevated temperature (+4/6°C) and standard CO_2 (400 ppm)	+	0	0	0	+	0	0	-	0	+	0
Elevated temperature (+4/6°C) and elevated CO_2 (800 ppm)	+	0	+	+	+	+	0	-	+	+	+

* 0 = no effects, similar to control. ** + = disease increase compared to control. *** - = disease reduction compared to control. ° n. = not tested.

An increase of downy mildew on grapes, of powdery mildew on zucchini, of Alternaria leaf spot on rocket salad (Tab. 1), of black spot on basil (Tab. 1) and of Phoma leaf spot on garden beet was observed when both CO_2 level and temperature increased. Powdery mildew of grape was not influenced by increasing carbon dioxide and temperature. Downy mildew of basil and rust affecting geranium increased at higher CO_2 levels, but at lower temperatures, while the combination of high CO_2 and high temperature lead to a reduction of the rust disease affecting bean (Tab. 1).

Regarding the effects of climate changes on Fusarium wilt of lettuce and rocket, the soil fungal and bacterial development was not affected by the different CO_2 and temperature levels, while an increasing disease incidence was observed at high CO_2 and high temperature (Tab. 1), probably through plant-mediated effects.

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