ASSESSMENT OF PHYSIOLOGICAL EFFECTS OF FUNGICIDES IN WHEAT

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INTRODUCTION

One of the most limiting factors in wheat production worldwide is related to phytosanitary problems which increase cost of production, generate yield losses and reduce grain quality. In order to achieve an optimum crop yield it is important to have an effective control of foliar diseases during the period between flag leaf emergency and milky ripeness. This is due to the fact that photosynthesis flag leaf is essential for an optimum grain filling.

Several strategies focused to control foliar pathogens have been used, among these the use of fungicides is one of the most widespread methods implemented in wheat crops. Apart from fungicidal effects, some fungicide classes like Qo-inhibitors have been reported to induce physiological modifications in crops. In consequence, increased tolerance to abiotic stress, delayed senescence of photosynthetic leaf area or prolongation of the green leaf area duration (GLAD) and modifications in the balance of plant growth regulators have been reported. These effects were often associated with a positive yield effect.

Physiological effects may be detected by destructive preparations of enzymes and pigments or the measurements of gas exchange. An excellent alternative to destructive methods is the use of imaging techniques, which give the possibility to have an early detection of changes caused by several factors such as biotic and abiotic stresses which may be limited to some parts of the crop plants. Near-range infrared (IR) thermography is a non-destructive method which allows the recording of the temperature of plant surfaces depending on differences in transpiration rate. Plant temperature is negatively correlated to transpiration rate.

MATERIALS AND METHODS

The effects of fungicides from various chemical groups on leaf and ear senescence of wheat were studied in a disease-free environment under greenhouse conditions. Fungicides were applied at two growth stages (GS), when the flag leaf ligule was visible (GS 39), and when emergence of inflorescence was completed (GS 59). Green leaf area duration was assessed weekly after the second fungicide application as percentage of green area of the leaf blades of the uppermost three leaves.

Digital IR-thermal images were taken at four growth stages: GS75, GS80, GS85 and GS90. The images were obtained by a Sterling-cooled infrared scanning camera (VARIOSCAN 3201 ST, Jenoptic Laser, Jena, Germany). The measurements were conducted between 5:00 pm and 7:00 pm in order to avoid physiological and environmental changes among measurements. The software

package IRBIS plus V 2.2 (Infratec, Dresden, Germany) was used to analyze the IR thermal images. The temperature of leaves and ears was analyzed; for each plant part, the average of fifty pixels from the digital images was used per replicate per treatment.

RESULTS AND DISCUSSION

Fungicides increased GLAD when compared to untreated wheat plants. This difference was more evident at the flag leaf than at F-1 and F-2. Additionally, this increment was higher when strobilurin and carboxamide fungicides were used as compared to the treatments with an azole or spiroxamine.

Differences in transpiration rate among treatments were confirmed by IR-thermal images; significant differences were detected regarding the temperature of leaves and ears between fungicide-treated and untreated plants (Tab. 1). At GS 75 and 80, differences in leaf and ear temperature were significant. In contrast, no significant differences in the ear temperature were detected among treatments at GS 90.

Table 1: Effect of fungicide treatments on the temperature (as a measure of transpiration activity) of ears and leaves of wheat cv. Passat at growth stages 75, 80, 85 and 90.

Treatment	Temperature [°C]							
	GS 75		GS 80		GS 85		GS 90	
	Ear	Leaf	Ear	Leaf	Ear	Leaf	Ear	Leaf
Untreated	23.7 a	22.5 a	20.4 a	18.1 a	25.3 a	24.4 a	24.3 a	23.4 a
Carboxamide	22.3 c	22.1 b	18.2 d	16.4 b	24.5 b	23.3 c	24.1 a	22.3 b
Strobilurin	23.1 b	22.3ab	18.9 c	16.5ab	24.8ab	23.4bc	23.9 a	22.7 b
Azole	23.1 b	22.4ab	19.5 b	16.6ab	24.8ab	23.7 b	24.2 a	23.1 a
Spiroxamine	23.2 b	22.4ab	20.2 a	16.4ab	25.1ab	23.7 b	24.2 a	23.2 a

Means in the same column followed by the same letter are not significantly different according to Tukey test ($p \leq 0.05$; $n = 15$).

A clear effect of carboxamide and strobilurin fungicides on wheat physiology was detected; their effect was more pronounced than those from the other fungicides. A direct relation was found between GLAD and transpiration rate, due to the fact that plants with longer GLAD had a lower temperature of leaves and ears.

Non-contact assessment of physiological changes in plants by IR-thermal images is an alternative to porometer measurements of plant transpiration which often cover only small leaf areas, in order to detect effects of fungicides on plant senescence. The non-destructive method allows the recording of modifications in plant transpiration in time series experiments. Transpiration of plants is an important physiological parameter that is regulated by water balance of tissue and is an indicator of physiological activity of leaves as primary source for yield formation in cereals.

Keywords: Green leaf area duration, leaf senescence, transpiration, water balance.