Induced resistance in plants against insects and diseases
IOBC-WPRS Bulletin Vol. 89, 2013
pp. 327-331

Effect of plant genotype on the efficacy of stimulators of plant defences in two horticultural pathosystems

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Abstract: Four stimulators of plant defences (SPD) were tested on two pathosystems: powdery mildew (PM) due to *Podosphaera xanthii* on melon and downy mildew (DM) due to *Bremia lactucae* on lettuce. More than 450 accessions of melon were screened for the stimulation of their defence reactions by a formulation with laminarin, BION® 50WG and CalFlux and more than 400 accessions of lettuce with BION, Calflux and a formulation with yeast extract (ABE IT 56). In the PM/melon pathosystem, only BION was able to induce resistance; in the majority of the accessions resistance was not activated but some accessions fully susceptible to PM in the control sprayed with water were very well protected by BION. In the DM/lettuce pathosystem, the three tested SPD could induce resistance, but again BION was the most effective. Close to half accessions of the 300 susceptible to Bl: 25 and a quarter of the 110 accessions tested with Bl: 26 were well protected against the tested strain by BION and some of these were also protected by CalFlux (13% and 14%, respectively) and few by ABE IT 56 (10% and 4%, respectively). In both pathosystems, the induced resistance seems to be strain-specific as some accessions were protected against one strain and not protected against another strain; nevertheless some promising accessions were protected against both strains.

Key words: lettuce, *Lactuca sativa*, melon, *Cucumis melo*, powdery mildew, downy mildew, *Bremia lactucae*, *Podosphaera xanthii*, accessions

Introduction

The stimulators of plant defences (SPD) could be a good alternative to fungicides (Oostendorp *et al.*, 2001; Vallad & Goodman, 2004) but there are conflicting results on their efficacy in different reports (Walters *et al.*, 2005). Results of the interest of SPD on disease control have been demonstrated in lettuce (Pajot *et al.*, 2001) or cucurbits (Koné *et al.*, 2009). One of the factors which has not been fully studied is the influence of the plant genotype. Indeed as SPD are acting through the plant metabolism, different cultivars or accessions could be more or less responsive. For instance, a difference of reactivity to BABA between tomato accessions was reported for protection against *Phytophthora infestans* (Sharma *et al.*, 2010). We report here some preliminary results on the evaluation of melon and lettuce genetic resources for their reactivity to some SPD against respectively powdery mildew (*Podosphaera xanthii*) and downy mildew (*Bremia lactucae*).

Material and methods

Stimulators of plant defences (SPD) and treatments

Four SPD were chosen after preliminary tests on the two pathosystems: *Podosphaera xanthii* (PM) on melon and *Bremia lactucae* (DM) on lettuce. A preparation (noted A in this paper) with laminarin extracted from algae was tested on melon. A yeast extract, ABE IT 56, supplied by Jouffray-Drillaud, was tested on lettuce. BION® 50 WG with acibenzolar-S-methyl supplied by Syngenta and CalFlux with Ca^{2+} and Zinc nitrate supplied by Ecoculture were tested on both pathosystems. The treatment was made by spraying the SPD on young plants (carrying 3-4 leaves for melon cultivated in pots in a glasshouse, and 2-3 leaves for lettuce cultivated in trays in a growth chamber at 24/18 °C with 16 h day-length). A control treatment was used in each experiment by spraying water.

Plant material and inoculation of the pathogens

A collection of 457 melon accessions and 402 lettuce accessions was tested in growth chamber experiments. A first screening of melon accessions was done on leaf discs inoculated by blowing dry spores five days after treatment. In a second series of experiments on the most promising accessions, the plants were inoculated by spraying conidia suspensions in water containing Tween 80; the plants were inoculated three days after treatments and incubated at 24/18 °C with 14 h day-length. Lettuce plants were inoculated with a suspension of 2×10^4 DM spores/ml at five days after treatment and incubated at 16/12 °C with 16 h day-length. European strains of both pathogens were used (04Sm2 and 08Sm9 for PM, Bl: 25 and Bl: 26 for DM).

Quantification of disease development and SDP efficacy

Ten days after inoculation, a visual evaluation of disease was done by scoring individual leaves. For PM on melon leaf discs, a scale from 0 (no symptom) to 9 (very severe sporulation) was used. For inoculations on melon plants, the percentage of leaf area covered by PM was used (from 0 to 100%). For DM on lettuce, the following scale was used: 0 = no spore, 1 = presence of very few spores, 2 = 1 to 2 cm^2 with spores, 3 = less than 50% area covered by spores or 4 = more than 50% area covered by spores. For the first screening, accessions were classified as reactive if the maximum scores on SPD-treated leaves were very low (PM score lower than 3 and DM score lower than 2) in comparison with water-treated leaves (PM score higher than 5 and DM score higher than 2). For the second series of tests, the efficacy was evaluated by the means of the scores on individual leaves (36 leaves from 18 plants for melon, 32 to 48 leaves from 16 plants for lettuce) for each treatment by calculating the percentage of the score of SPD-treated leaves divided by the score of water-treated leaves.

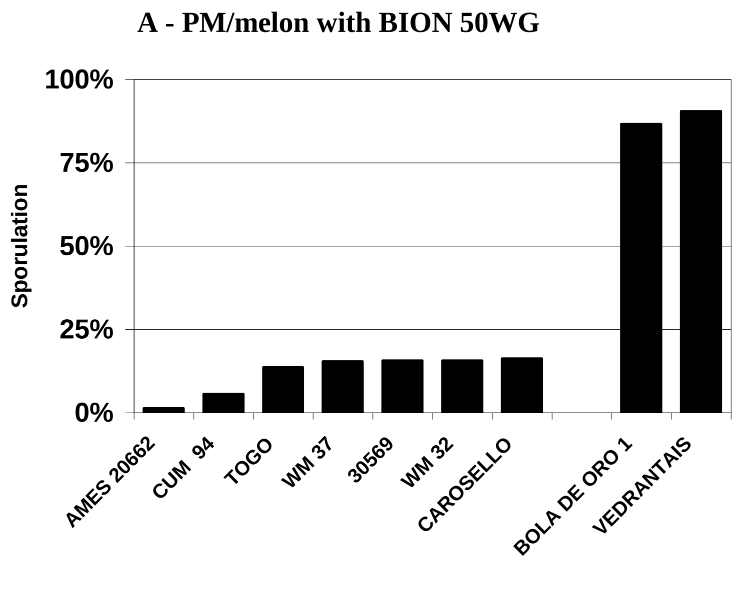
Results and discussion

Screening of melon and lettuce genetic resources

In the first screening, with strain 04Sm2 of PM on melon leaf discs and with two Bl strains of DM on 4 plants on lettuce, fewer than 20% of tested melon accessions, and 50% and 29% of tested lettuce inoculated respectively with Bl: 25 and Bl: 26, were protected by at least one of the SPDs (Table 1).

In the second series of tests on the PM/melon pathosystem, the efficacy of BION and the varietal diversity of the reactivity were confirmed in several experiments on plants (Figure 1A). But the few accessions reactive to A or CalFlux (12 and 3, respectively) on leaf discs were unprotected by these SPD on young plants.

In the second series of tests on lettuce, the efficacy of the three tested SPDs was confirmed with varietal differences (Figure 1B). Many accessions were reactive with BION, in all cultigroups (Butterhead, Batavia type, loose leaf lettuce and Cos) including old and modern cultivars. For the DM/lettuce pathosystem, some accessions were also confirmed as reactive to CalFlux or to ABE IT 56 or to the three SPD (Figure 1B).



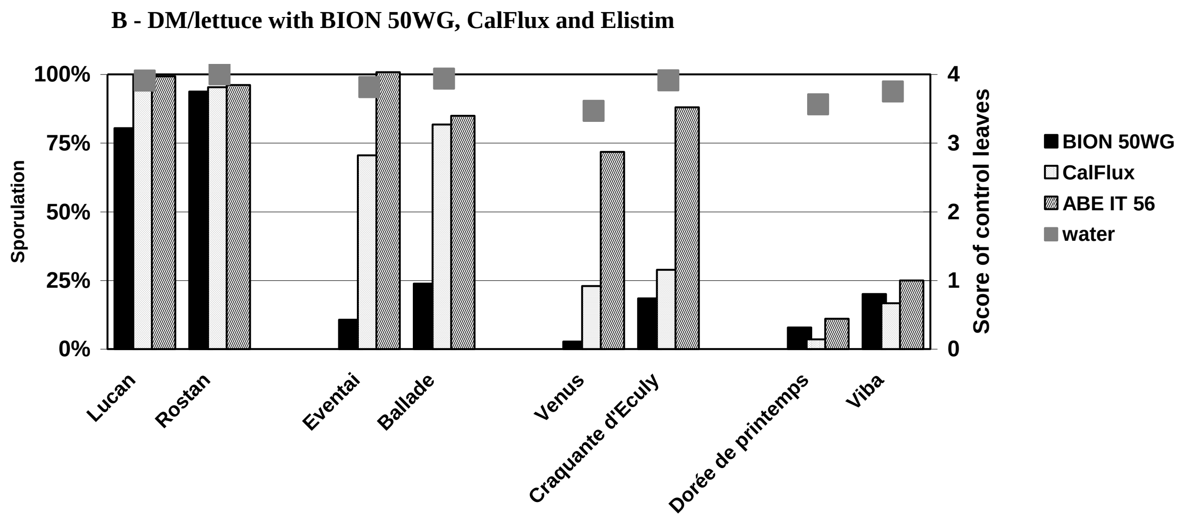


Figure 1. Protection of 9 melon accessions against powdery mildew (PM, strain 04Sm2) by BION (A) and of 8 lettuce accessions against downy mildew (DM, strain Bl: 26) by BION, CalFlux and ABE IT 56 (B). Data are averages of sporulation scores on SPD-treated leaves expressed as percent of average scores on water-treated leaves.

Effect of strains of the pathogen

In the second series of tests, the protection provided by SDPs was evaluated on two strains of each pathogen. For a large majority of the accessions there was a good correlation for the sporulation with both strains (Figure 2). But several accessions were protected against only one of the two tested strains.

For both pathosystems, several accessions were well protected against both tested strains. For 7 melon accessions, the sporulation score on BION-treated leaves was lower than 30% of that on control leaves with both strains (Figure 2A). For 7, 4 and 1 lettuce accessions respectively, the scores on BION-, CalFlux- and ABE IT 56-treated leaves were lower than 35% of that on control leaves with strain Bl: 25 as well with Bl: 26 (Figure 2B).

Table 1. Reactivity of melon and lettuce accessions to SPD (A, BION, CalFlux and ABE IT 56) for induced resistance against one strain of powdery mildew for melon and two strains of downy mildew for lettuce (Bl: 25 and Bl: 26).

		Melon	Lettuce with Bl: 25	Lettuce with Bl: 26
Total number of accessions tested		457	300	110
Acc. reactive to one SPD	A	4	nt*	nt
	BION (B)	67	94	16
	CalFlux (C)	1	8	4
	ABE IT 56 (D)	nt	4	0
Acc. reactive to two SPD	A and B	8	nt	nt
	B and C	2	18	8
	B and D	nt	12	1
	C and D	nt	1	0
Acc. reactive to three SPD	B, C and D	nt	13	3

* nt = not tested

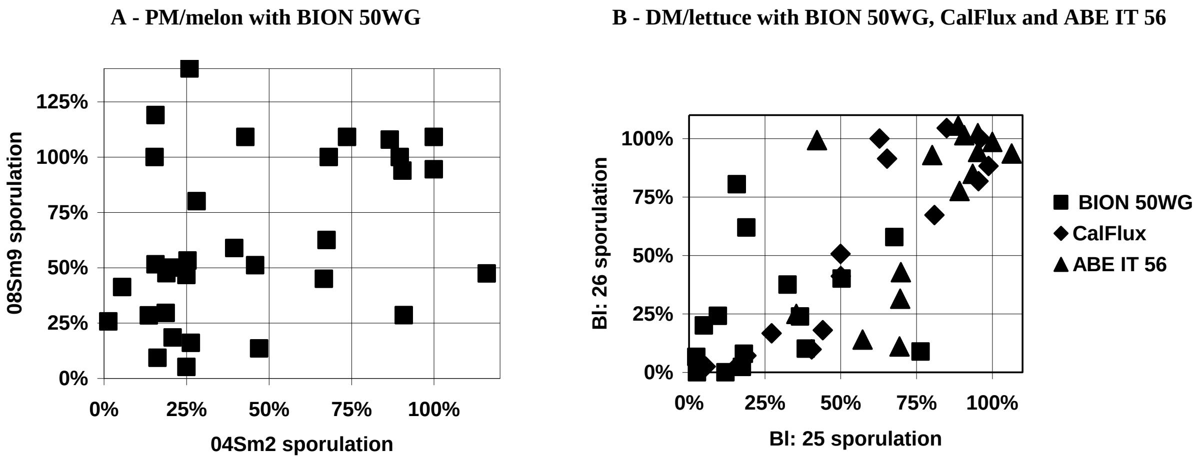


Figure 2. Protection against 2 strains of PM by BION on 32 melon accessions (A) and against 2 strains (Bl: 25 and Bl: 26) of DM by BION, CalFlux and ABE IT 56 on 15 lettuce accessions (B). Means of the scores of sporulation on SPD-treated leaves in percentage of the means of the scores of water-treated leaves.

Conclusions

In both pathosystems, strong varietal differences in the reactivity to SPD have been observed and BION was the most effective SPD. In the PM/melon pathosystem, the two other tested SPD were not effective on any of the tested accessions, but in the DM/lettuce pathosystem CalFlux and ABE IT 56 were also effective to protect some accessions. This genetic variability could be interesting to use in breeding programs to increase the level of protection provided by SPDs in the field. The genetic control of the reactivity could be studied in progenies between reactive and non-reactive accessions. In the future, this could be a genetic character to cumulate with resistance genes to try to increase the level and the durability of resistance.

Acknowledgements

We thank the French Office National de l'Eau et des Milieux Aquatiques (ONEMA) and the GIS-PICLég for financial support of the DEFILeg project. We thank L. Jean for excellent technical assistance.

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