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Effect of solar light on the fate of elicitor acibenzolar-S-methyl, during the use phase of its life cycle



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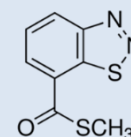
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Introduction

The light distribution within a plant canopy governs the lifetime of the active ingredient of phytosanitary products and the formation of degradates on the leaves. Their early dissipation makes necessary the repetition of applications and thus leads to a chemical crop input increase. Our work aims to analyse **the links between the canopy architecture, the microclimate and the active ingredient photodegradation focusing on the biological effects on plants through the study of induced natural defense systems (SDN)**. The work presented here focuses on the first step of the project : to determine the photodegradability of selected active ingredients upon irradiation with solar light and monitor the elicitor activity of the active ingredient and photoproducts on cell culture system.

The chosen active ingredient is Acybenzolar-S-Methyl (ASM). This analog of salicylic acid has no direct effect on the pathogen but exerts a stimulation on the plant defense system. It is marketed in France as Bion. ASM absorbs solar light intensively below 350 nm; therefore it can potentially undergo photolysis.



Photochemical transformation

Figure 1 shows that ASM undergoes fast photolysis when it is deposited on wax films that mimic the epicuticular layer of leaves and exposed to simulated solar light (400 W/m² within the range 290-800 nm). Under these conditions, its half-life is only one hour. In a good agreement, the photolysis quantum yields in organic solution are comprised between 0.067 and 0.092, confirming the good efficiency of the photolytic process and thus the photolabile character of ASM.

Figure 2 gives the spectral evolution of an ASM solution in acetonitrile upon irradiation. The characteristic bands of ASM at 250 and 320 nm disappear while new bands around 225, 270 and 350 appear.

The main photoproducts P₁ and P₂ formed on wax films in beginning of the irradiation are shown on the 2D chromatogram (Figure 3). Their absorption spectra are given in Figure 4.

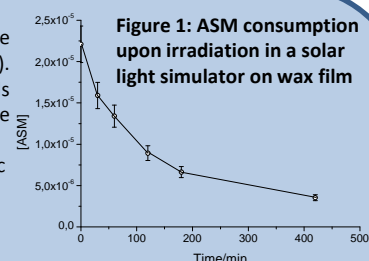


Figure 1: ASM consumption upon irradiation in a solar light simulator on wax film

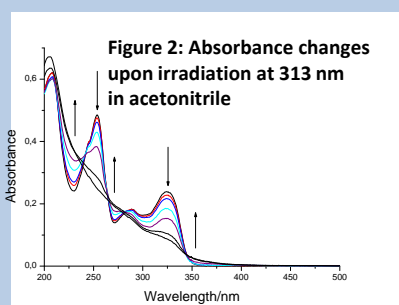


Figure 2: Absorbance changes upon irradiation at 313 nm in acetonitrile

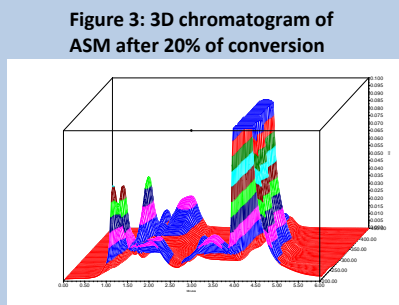


Figure 3: 3D chromatogram of ASM after 20% of conversion

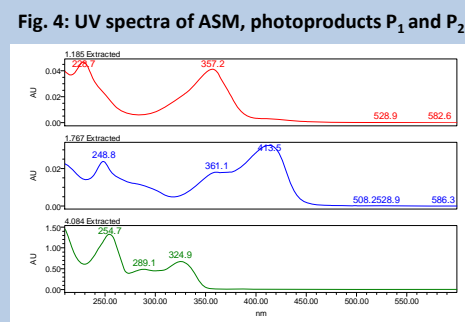


Figure 4: UV spectra of ASM, photoproducts P₁ and P₂

Elicitor activity

Figure 5: Pathogenesis-related protein activities PR2 (glucanase) and PR3 (chitinase) measured in extracellular medium of tobacco BY2 cells elicited with 900µM ASM.

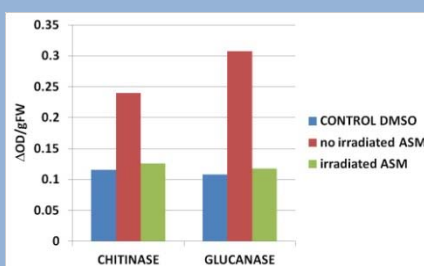
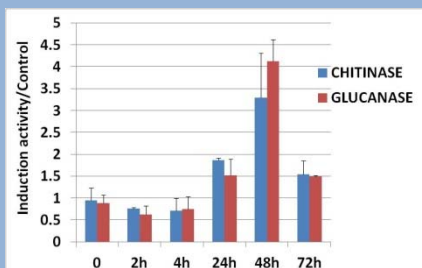
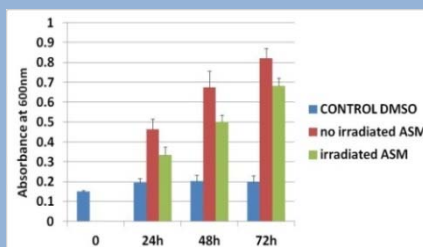


Figure 6: Impact of irradiation on ASM-inducing chitinase and glucanase activities. The activities were measured after 48h BY-2 elicitation. ASM was irradiated for 2h in the solar light simulator (70% of conversion).

Figure 7: Impact of irradiation on ASM-inducing cell death of BY2 tobacco cells. ASM was irradiated for 2h in the solar light simulator.



Conclusion ASM undergoes a fast photolysis when it is exposed to solar light. This phototransformation leads to a loss of eliciting properties. These data could explain lower efficiency of active ingredients such as ASM under field conditions.