

Synthesis of Six Heterocyclic Multifunctional Alkylating Agents and Evaluation of Their Activity against *Pyrenophora avenae* and *Blumeria graminis* f.sp. *hordei*

Fiona M. Anderson,¹ D.R. Walters*,² and D.J. Robins¹

Six heterocyclic alkylating agents were synthesized and examined for activity against the oat stripe pathogen *Pyrenophora avenae* on agar plates and against the barley powdery mildew fungus *Blumeria graminis* f.sp. *hordei* on barley seedlings. Radial growth of *P. avenae* was not significantly affected by any of the compounds, but four of them, α,α -bis[4,7-bis(2-chloroethyl)-1,4,7-triazacyclononane]-*para*-xylene [3], 1,4,8,11-tetra(2-chloroethyl)-1,4,8,11-tetraazacyclotetradecane [4], 8,11-bis(2-chloroethyl)-1,4,8,11-tetraaza-5,7-oxocyclotetradecane [5] and 7,16-bis(2-chloroethyl)-1,4,10,13-tetraoxa-7,16-diazaoctadecane [6], gave significant reductions in biomass of *P. avenae* grown in liquid culture and in powdery mildew infection on barley when used at 25 μ M. Polyamine biosynthesis was examined by following the incorporation of labeled ornithine into polyamines in *P. avenae*. The four compounds 3-6 which reduced mildew infection all reduced the flux of label through to the polyamines in *P. avenae*. Whether the reductions in mildew infection caused by these compounds is related to reduced formation of polyamines is not known and awaits investigation.

KEY WORDS: Synthesis; antifungal activity; *Pyrenophora avenae*; *Blumeria graminis*.

Received Nov. 12, 2004; accepted March 13, 2005; <http://www.phytoparasitica.org> posting May 22, 2005.

¹Dept. of Chemistry, University of Glasgow, Glasgow G12 8QQ, UK.

²Crop and Soil Research Group, Scottish Agricultural College, Edinburgh EH9 3JG, UK. *Corresponding author [e-mail: dale.walters@sac.ac.uk].