Wednesday March 31

Parallel session 5: Fungal Way of Living: Sex and Other Encounters

PS5.1

The dodge of blotch: Saving sex in *Mycosphaerella graminicola*

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Mycosphaerella graminicola is the causal agent of septoria tritici blotch, currently the most important disease of wheat in Europe. Despite the recent identification of 15 resistance genes and their potential application in plant breeding, disease control is currently achieved mainly by fungicides. However, fungicide resistance development in natural *M. graminicola* populations frequently occurs and is a serious concern. Depending on the fungicides this may develop gradually, such as with resistance to azoles, or much more rapidly as was observed for strobilurin fungicides. In order to understand this rapid spread of resistance we have performed a range of crossing experiments that demonstrate that external stress factors hamper disease development but cannot prevent sexual development. As *M. graminicola* is a heterothallic bipolar pathogen, sexual development requires two mating partners - carrying different mat alleles (mat1-1 or mat 1-2) - that both produce female and male organs. We use an in planta crossing protocol that reliably enables the isolation of segregating/mapping populations. The first stress factor that we used was host resistance. Various crosses on a range of cereal hosts indicated that sex always takes place as long as one of the mating partners is virulent. Thus, even an avirulent isolate that does not establish a compatible interaction with the host plant is perfectly able to enter into the sexual process resulting in viable ascospores. As a consequence the genes of such an avirulent isolate are transmitted to subsequent generations. This is fundamentally different from many other host-pathosystems where avirulent isolates - and their genes - are lost in subsequent generations. We used strobilurin fungicides as a second stress factor by crossing sensitive and resistant isolates under various strobilurin concentrations (3-200%). Although strobilurins prevent disease development of sensitive isolates, and as a consequence minimize biomass, abundant sexual development occurred under all conditions, thus irrespective of the applied strobilurin concentration. Moreover, our results showed that the 'stressed' mating partner – the sensitive parent – acted as the preferred paternal partner. Thus, external stress factors on avirulent or sensitive isolates do not preclude the production of *M. graminicola* spermatia that effectuate viable ascospore production. The fact that the sensitive isolates are preferred paternal donors – and consequently the resistant strains are maternal donors – in the sexual process resulted in major shifts in strobilurin resistance in the segregating populations as the target site for strobilurins is on the mitochondrial genome. A minimal dose of 6% strobilurin already rendered entire populations resistant to these compounds. This explains the rapid pan-European spread of strobilurin resistance in M. graminicola, likely in temporally and geographically independent occasions, with no loss of nuclear genetic variation. The recently discovered genome plasticity of *M. graminicola* may contribute to its ability to overcome environmentally adverse conditions.