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Developing Fungicide Control Programmes for Blotch in Irish Winter Wheat Crops

Kildea S, Dooley H, Phelan S, Mehenni-Ciz J, Spink J

Department of Crop Science, Teagasc Crops Environment and Land Use Programme, Oak Park, Carlow, Ireland

Email: stephen.kildea@teagasc.ie

ABSTRACT

Control of Septoria tritici blotch of winter wheat in Ireland is currently dependent on the timely application of fungicides. Expectant restrictions in availability resulting from changes in EU regulations and the prospect of resistance in the target pathogen *Zymoseptoria tritici* are a major concern to the sustainability of control programmes and consequently wheat production. To delay the potential development and subsequent spread of resistance, continual monitoring and fungicide programme optimizations are required. This paper describes the sensitivity of the Irish *Z. tritici* population to the main fungicide groups used for its control and outlines potential means to delay the spread of detected resistances.

INTRODUCTION

Septoria tritici blotch (STB) caused by the fungal pathogen *Zymoseptoria tritici* is currently the most economically destructive disease of winter wheat in Ireland. The combination of susceptible host cultivars and a mild and wet climate, often experienced in Ireland, allow the disease to thrieve during the wheat grain filling period of June and July. Under these conditions if left controlled STB has the potential to reduce yields by up to 50%. Although host resistances to STB have been increasing, as these ressitances have often been associated with negative impacts upon yield and uptake at grower level has unsurprisingly been slow. Fungicide control has therefore been relied upon to provide STB control to prevent associated yield losses. Currently as part of winter wheat disease control programmes Irish growers regularly apply fungicides 3-4 times each season, at or close to the label recommended rate, with STB a primary target of each application. These fungicides are applied to specific stages of the crops development – late tillering, final leaf 3, flag leaf and mid-flowering. As these are different developmental stages in the crops life careful consideration of fungicide active(s) in each application, such as protective or curative in nature, is critical to maximise disease control. Unfortunately, increased restrictions on the availability of key fungicides and the putative development and rapid spread of fungicide resistance in Irish *Z. tritici* populations has

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the potential to limit the future ability to control STB in Irish crops. As a consequent the sustainability of winter wheat production in Ireland has been questioned (Jess et *al.* 2014). To provide support and guidance to Irish wheat growers on optimum control of STB under Irish conditions and to delay the onset and spread of such resistances Teagasc conduct extensive fungicide sensitivity monitoring programmes, together with applied field trials focusing on disease control and anti-resistance measures. The monitoring programme focuses on commercial crops, with sensitivity determined using an *in vitro* microtiter assay.

AZOLE SENSITIVITY

Since 2005 the sensitivity of the Irish *Z. tritici* population to the azole fungicides has been declining. This has been most noticeable for the main azoles epoxiconazole and prothioconazole, whilst a broad range of sensitivity to metconazole and tebuconazole has continued to be observed in the wider population (Figure 1). These changes have been associated with a variety of resistance mechanisms, found increasing in combination with one another. These include an increasing complexicity of mutations in the target site gene *CYP51* (including D134G, V136A/C, A379G, I381V, Δ459/460, Y461S/H, N513K and S524T), overexpression of CYP51 assoaicted with inserts in the promoter region and the increased efflux activity of the MgMFS1 transporter. These observed reductions in sensitivity have impacted upon the protective and curative capacity of the various azoles, with all the main azoles now providing comparable levels of moderate control (Dooley et *al.* 2016a).

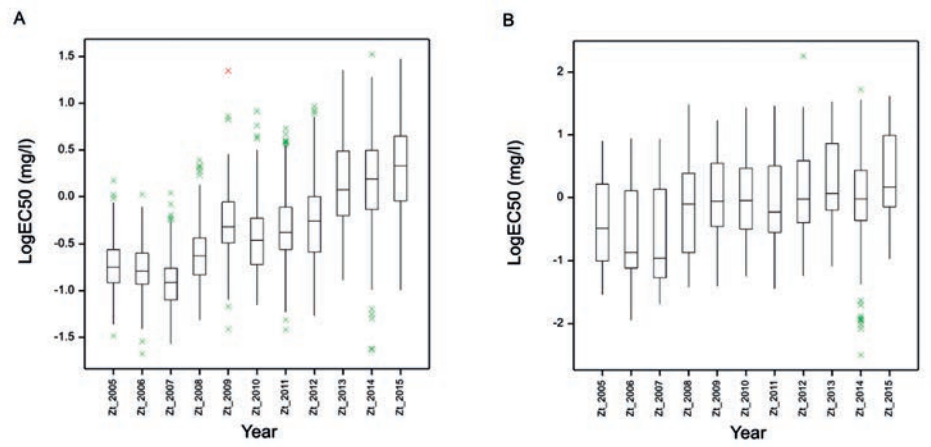

Figure 1 Sensititvity of Irish *Zymoseptoria tritici* population to A) epoxiconazole and B) tebuconazole. Sensitivity determined using a microtiter plate assay described by Dooley et *al.* 2016a. Horizontal lines indicate median and x indicate outliers.

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SDHI SENSITIVITY

Routine sensitivity to the succinate dehydrogenase inhibitors (SDHI) has been ongoing as part of the Teagasc fungicide sensitivity monitoring programme since 2011; with a baseline sensitivity established using a collection of isolates from untreated crops 2005-2010. During the 2011-2014 seasons no major changes in sensitivity were observed amongst the Irish *Z. tritici* population to the SDHIs. In 2015 strains of *Z. tritici* originating from both commeircal crops and field trials were detected exhibiting moderate to high levels of resistance (Dooley et *al.* 2016b). The majority of these strains had a mutation in the *SdhC* subunit, including T79N, T79I, W80S, N86S and H152R, with the most frequent being T79N (Figure 2). All mutations reduced sensitivity to all commercial available SDHI fungicides used for *Z. tritici* control, albeit differing in ability to do so. With the exception of H152R, all mutations only conferred low to moderate reductions in sensitivity. H152R significantly reduced sensitivity to all commercially available SDHIs (Figure 2).

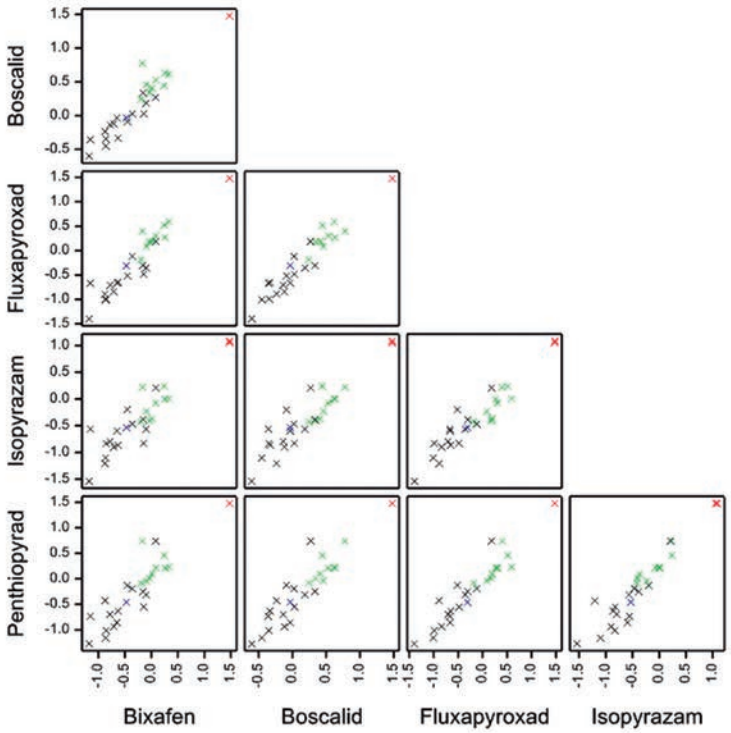

Figure 2 Cross-sensitivity (LogEC50 mg/l) of a collection of *Zymoseptoria tritici* from Oak Park, Carlow to the main SDHI fungicides applied to winter wheat crops in Ireland. Colours represent mutations in the *SdhC* subunit: black = wild type, green = T79N, blue = W80S, red = H152R. Isolates collected in July and November 2015 and sensitivity determined using a microtiter assay as described by Dooley et *al.* (2016a).

DEVELOPING STB CONTROL PROGRAMMES

To alleviate the reliance placed upon fungicides to provide STB control it is essential to incooperate all aspects of crop production that can influence the epidemiology of *Z. tritici* into control programmes. This must include the delayed sowing of resistant varieties and ensuring all subsequent agronomic practices do not further promote disease development. In specific relation to fungicide programmes, it is enviatable that fungicide usage will lead to selection for resistance. However, the speed at which this developes and spreads can be influenced by the practices implemented. Fungicides should only be applied where necessary. Under Irish conditions for STB control this should be once the third last leaf has emerged, the final leaf has emerged and mid-anthesis as these are best suited to protect the upper canopy and ear from disease. Choice and rates of fungicides used at each of these applications should reflect local pressures and past agronomic choices (variety and sowing date), but should always include a mix of actives from different fungicide groups, including where possible a multisite. Given the diversity of azole sensitivity that now exists in the Irish population alternation of different single azoles productsthat exhibit different sensitivity profiles can reduce selection compared to continual use of the same azole or mixtures of azoles (Dooley et *al.* 2016).

ACKNOWLEDGMENTS

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