Fungicide application timing and control of sclerotinia stem rot in England in 2008 and 2009.

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Abstract

The effectiveness of boscalid and iprodione + thiophanate-methyl applied as single fungicide applications at early flower (GS 4,3), mid-flower (GS 4,5), late flower (GS 4,8/9) or in sequence for the control of sclerotinia stem rot was evaluated in field trials in 2008 and 2009. Stem rot in untreated plots was moderately severe, with pre-harvest incidences of 33.3% in 2008 and 20.5% in 2009. In both years, a single mid-flower application of boscalid was more effective at reducing sclerotinia stem rot and improving yield than an early flower application, which was applied 7 or 9 days earlier. Fungicides applied at both early and late flowering stages, where control was sub-optimal for single applications, gave similar control to the optimum timing at mid-flower. The effectiveness of fungicide timings could be interpreted by using the infection criteria as defined by the SkleroPro model, retrospectively. This showed that conditions conducive to infection occurred on six dates over a 5 week period in 2008 and six dates over a an 11 week period in 2009. The significance of fungicide timing and duration of protection from individual applications on the control of stem rot in relation to weather-based risk is discussed.

Introduction

Stem rot (*Sclerotinia sclerotiorum*) on winter oilseed rape caused significant yield losses in 2007 and 2008 in the UK (Gladders *et al*., 2008). Despite 2009 being the lowest year nationally for sclerotinia infection in England and Wales for 13 years, with less than 1% of plants affected as reported by Crop Monitor (www.cropmonitor.co.uk), the risk for disease development at sites with a history of severe epidemics still remains high. The use of fungicides for stem rot control has increased after these epidemics but some fungicide-treated crops still have high levels of the disease. This paper examines the significance of fungicide application timing in relation to weather- related infection criteria for the control of sclerotinia stem rot in oilseed rape.

Materials and Methods

Replicated small plot experiments were done at two sites with a history of sclerotinia infection in 2007 and 2008. The timing of fungicide sprays in relation to different developmental stages of flowering was investigated in winter oilseed rape over two years in Herefordshire: on cv. Castille sown on 1 September 2007 at Weobley in 2008 and cv. Es Astrid sown on 25 September 2008 at Vowchurch in 2009. Fungicides were applied in 200 L water ha^{-1} as boscalid 0.25 kg a.i. ha^{-1} (as Filan) or iprodione + thiophanate-methyl (iprod+tm) 0.375 + 0.375 kg a.i. ha^{-1} (as Compass) at early flowering (22 April, GS 4,3), mid-flowering (1 May, GS 4,5) or end of flowering (21 May, GS 4,9) in 2008 and early flowering (22 April, GS 4,3), mid-flowering (29 April, GS 4,5) or end of flowering (20 May, GS 4,8) in 2009. Each trial was a randomised block design consisting of four replicates, with plot size 3.0 m × 24.0 m. All stem rot assessments, reported here as disease incidence, were made on 100 plants per plot in both years. One pre-harvest assessment was done on 28 June (GS 6,3) in 2008 and two assessments, post-flowering and pre-harvest, on 3 June (GS 4,9 5,3) and 1 July (GS 6,3) respectively in 2009. Yields were adjusted to 91% dry matter and all data were analysed by analysis of variance (ANOVA). Meteorological data from the ADAS Rosemaund weather station (Preston Wynne, Herefordshire) was used to determine when weather conditions conducive to infection occurred in each year. This was done by using the weather-related criteria for infection from the SkleroPro model (>80% relative humidity and temperatures 7°C and above for $\geq$23 hours) developed for sclerotinia stem rot in Germany (Koch *et al*., 2006, 2007).

Results

Sclerotinia stem rot was moderate in both years with 33.3% plants affected in untreated plots in 2008 and 20.5% in 2009 when assessed pre-harvest (Table 1). In 2008, fungicide application at mid-flower, regardless of active ingredient, significantly reduced stem rot incidence compared to the untreated control. Both early and late- flower fungicide applications did not significantly reduce stem rot individually, however, when applied in sequence gave control of stem rot similar to a single mid-flower fungicide application. Early and mid-flower fungicide applications of boscalid significantly improved yield compared to the control, by 0.61 t ha^{-1} and 1.29 t ha^{-1} respectively (Table 1). Application of fungicides at early and late flower in sequence resulted in a yield improvement of 1.36 tonnes ha^{-1} over the untreated.

In 2009, the effect of fungicide timing on sclerotinia incidence was assessed post-flowering on 3 June and pre-harvest on 4 July. Both early and mid-flower fungicide application timings significantly reduced sclerotinia incidence, with consistently less disease where fungicides were applied at mid-flower. Stem rot incidence where iprodione + thiophanate-methyl was applied at late flower did not differ significantly from untreated plots. Despite this, all treatments significantly improved regardless of fungicide timing when compared to untreated plots, with an additional 0.35 tonnes ha^{-1} from early flower and 0.59 tonnes ha^{-1} from mid-flower applications over the untreated. The early flower followed by late flower programme improved yield by 0.72 tonnes ha^{-1}, similar to the response to a single mid-flower fungicide. Late flower application of iprodione + thiophanate-methyl improved yield by 0.31 tonnes ha^{-1}.

Using the infection criteria from the SkleroPro model, six dates were identified as meeting these criteria during flowering in 2008: 22 and 29 April, 15, 16, 26, 27 and 28 May (Figure 1). All the infection periods occurred between early flowering and the end of flowering. In 2009, infection periods were identified on 9 and 16 April, 13, 14 and 27 May, and 6 June (Figure 1) and occurred when the crop was at yellow bud and early flowering, through to mid- to end of flowering during May. Most stem rot occurred at mid-flowering and late flowering stages. The period of protection offered by each application, assuming fungicide persistence of 3 weeks, is shown in Figure 1.

Table 3. Sclerotinia incidence (% plants affected) and yield (tonnes ha^{-1}) in 2008 and 2009.

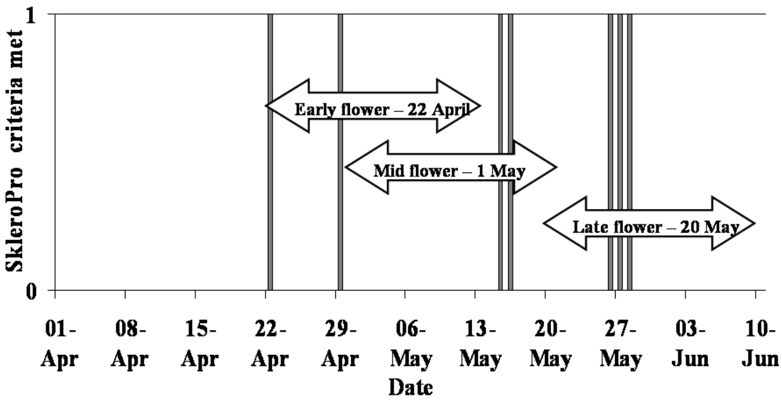
Application timing			2008		2009		
Early flower GS 4,3	Mid flower GS 4,5	Late flower GS 4,9	Incidence (%) 28 June	Yield (tonnes ha^{-1}) 4 August	Incidence (%) 3 June	1 July	Yield (tonnes ha^{-1}) 14 August
Untrt	Untrt	Untrt	33.3	3.81	12.3	20.5	4.18
boscalid	-	-	20.0	4.42	4.0	10.8	4.53
-	boscalid	-	11.3	5.10	1.8	5.5	4.77
-	iprod+tm	-	14.8	4.96	1.5	13.0	4.58
-	-	iprod+tm	21.0	4.49	6.8	18.5	4.49
boscalid	-	iprod+tm	13.0	5.11	2.5	5.8	4.90
		FPr P=0.05	0.123	<0.001	<0.001	<0.001	<0.001
		SED (51 df)	6.72	0.231	1.75	2.73	0.105

Discussion

Fungicide application can significantly reduce the incidence of sclerotinia stem rot and improve yield, however, currently available fungicides have little or no curative activity which make application timing critical (Gladders *et al*., 2009). It was clear in both 2008 and 2009 that a single fungicide application at mid-flowering was more effective than the same fungicide applied at early or late flowering stages. Using this information in combination with the weather-related infection criteria from the SkleroPro model (Koch *et al*., 2006, 2007) to determine when stem rot developed in 2008 and 2009, it was found that single early and mid-flower fungicide applications protected during different risk periods. The control of stem rot was consistent with treatments providing protection for about 3 weeks after application. In both years, the mid-flowering sprays did not protect the crop against late infection. Flowering can last between 4 and 8 weeks depending on the crop and two fungicide applications will be required to protect the crop during the main flowering period. The use of infection criteria from the SkleroPro model has proved useful for explaining why spray timings varied in their efficacy. However, there is currently no predictive model available to growers in the UK to assist with fungicide application decisions in real time.

Single well-timed mid-flower fungicides have been shown to give yield responses of over 2 t ha^{-1} (Gladders *et al*., 2009) where stem rot incidence was >80%. This study has demonstrated the potential for significant yield loss when disease incidence is much lower (20-30%) if application timing is sub-optimal. The optimum timing is difficult to predict and a programmed approach carries a lower risk of poor control. Although single application timings may be sub-optimal for control of sclerotinia (e.g. when applied early flower or end of flowering), combining early flowering sprays with a second spray about 3 weeks later can give provide similar stem rot control to the best single timing. Given the potential for high losses with single spray approaches, two spray programmes are an option for sites with previous stem rot issues to simplify stem rot management and reduce the risk when infection criteria are met over a prolonged flowering period.

A (2008)



B (2009)

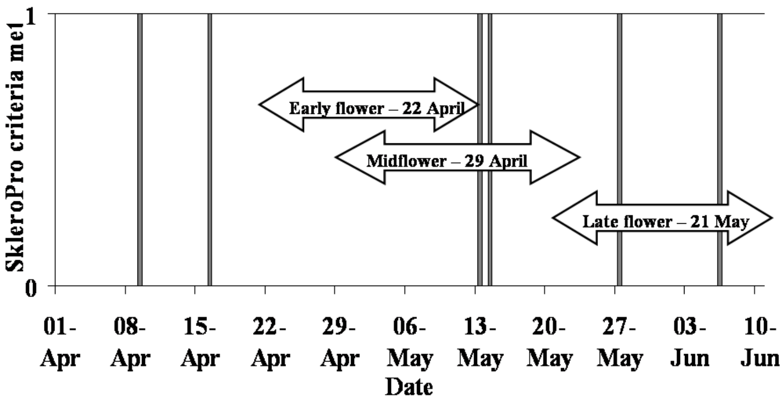


Figure 1. Dates where the infection criteria from the SkleroPro infection model were met in relation to the persistence of protection from single fungicides (3 weeks) applied at early and mid-flower in A - 2008 and B - 2009.

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