Less yellow spot in wheat: progress towards a decision support tool that will predict when yellow spot spores are released from the previous season stubble

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Key messages

- The fungus that causes yellow spot survives from one season to the next on the previous season's wheat stubble. Sexual spores (ascospores) develop on this stubble and cause yellow spot infection in the current season's wheat crop. The timing of spore maturation on this stubble is influenced by environmental factors (rainfall and temperature). Yellow spot ascospores mature and are released from previous season's stubble earlier in the southern cropping area of Albany compared with central (Northam) and northern (Eradu) cropping areas of the WA Grainbelt.

- Progress has been made towards developing a decision support tool (DST) that predicts the timing of yellow spot ascospore release at different locations in the WA Grainbelt. An ascospore maturity model has been developed and validated using epidemiology data from three locations in WA.

Aims

To develop a decision support tool that would assist wheat growers, advisors and researchers make informed decisions about yellow spot management (time of sowing and timing of fungicide applications) in wheat.

Method

Epidemiology

Wheat stubble infected with yellow spot during the growing season was collected after harvest in November each year in 2012, 2013 and 2014. In December of each of these years' sub-samples of stubble were placed on the soil surface at Albany, Northam and Eradu and left to weather under natural environmental conditions at these locations over the summer, autumn and winter of the following year.

At fortnightly intervals from March each year in 2013, 2014 and 2015 sub-samples of stubble from each treatment were collected and inspected for sexual fruiting bodies (pseudothecia). The maturation stage of the spores (ascospores) within these fruiting bodies was assessed using a microscope. Based on these assessments, the observed maturation or onset date was recorded for each location in each year and the percentage of fruiting bodies that contained mature spores (i.e. those with the potential to cause primary yellow spot infection) was determined.

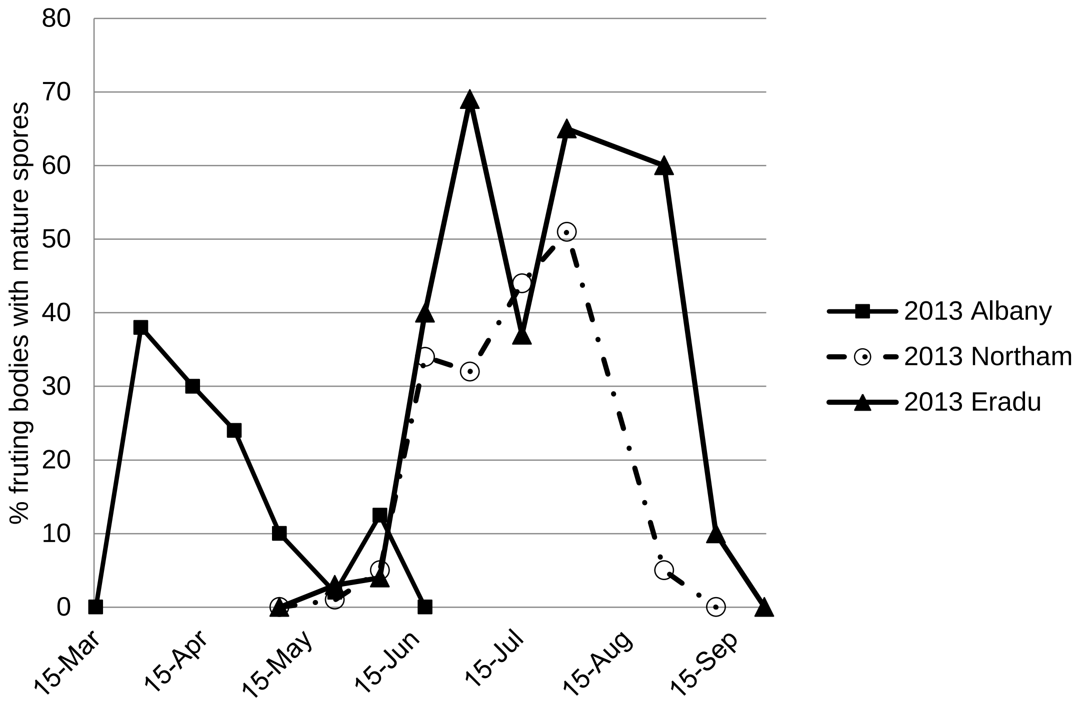
Model development and validation

A mathematical model for yellow spot ascospore maturation was developed using quantitative data obtained from epidemiology trials conducted over 3 seasons from 2010 to 2012. The model uses actual weather data obtained from weather stations and epidemiology parameters to predict when the fruiting bodies of the fungus that causes yellow spot will contain ascospores that are sufficiently mature to initiate yellow spot infection. The model was validated (tested for accuracy of prediction) by comparing predicted ascospore maturation dates with observed ascospore maturation dates at three locations in WA in 2013, 2014 and 2015. The deviation (days) between observed and predicted was recorded. The prediction was determined as being acceptable if the predicted date of onset was within 14 days of the observed date of onset. The 14 day criterion was selected as observed maturity was done at fortnightly intervals in the epidemiology experiments described above.

Results

Epidemiology

Yellow spot ascospores mature and are released from previous season's stubble earlier in the southern cropping area of Albany compared with central (Northam) and northern (Eradu) cropping areas of the WA Grainbelt (Figure 1). The date of onset of maturity for Albany ranges between the earliest observed date of 26 March in 2013 and the latest observed date of 9 June in 2014. In Northam and Eradu the earliest observed date of onset of maturity is 23 May 2013. The latest observed dates of onset of maturity are 25 June 2014 in Northam and 13 July 2015 in Eradu.



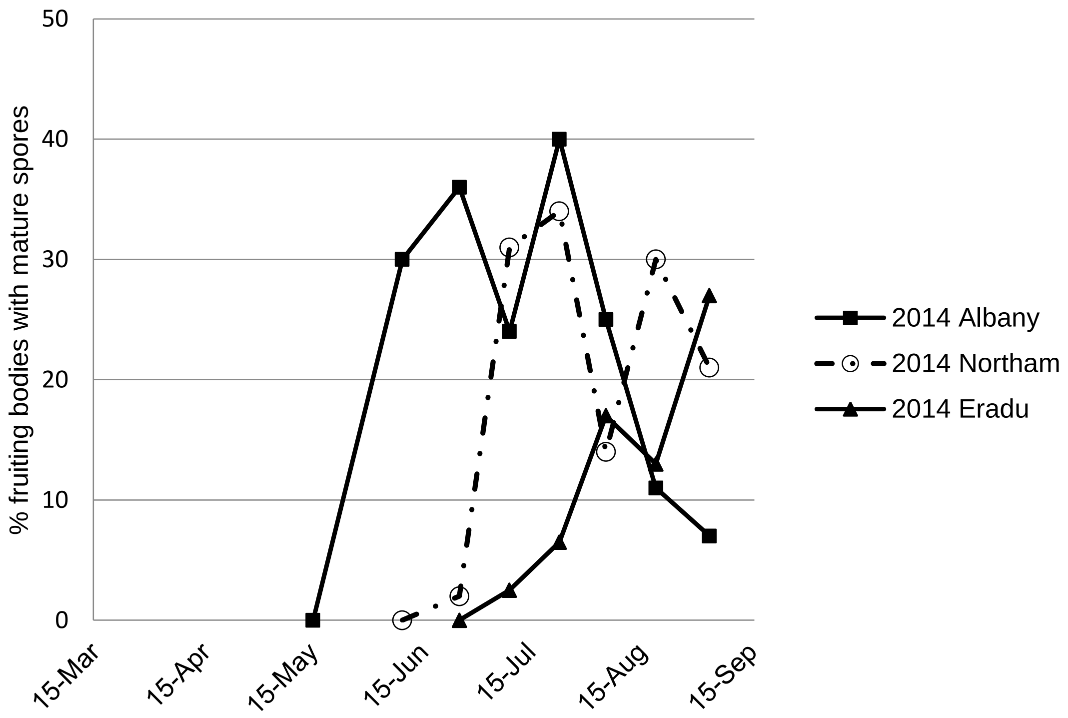


Figure 1. Two examples of earlier maturation of the fungus that causes yellow spot on stubble weathered in the southern cropping area at Albany compared with the central (Northam) and northern (Eradu) cropping areas of the WA Grainbelt. The graph shows the maturity progress of yellow spot fruiting bodies on wheat stubble at three locations in 2013 (an early maturing year) and 2014 (a late maturing year).

Model validation

The yellows spot spore maturation model predicted the timing of the onset of spore maturity to within 14 days of the observed spore maturity onset in five of the nine locations/years used in the validation testing. For Albany, the model predicted mid-late May maturation in all three years. In two out of the three years this predicted maturation was more than 14 days later than observed spore maturity (Figure 2).

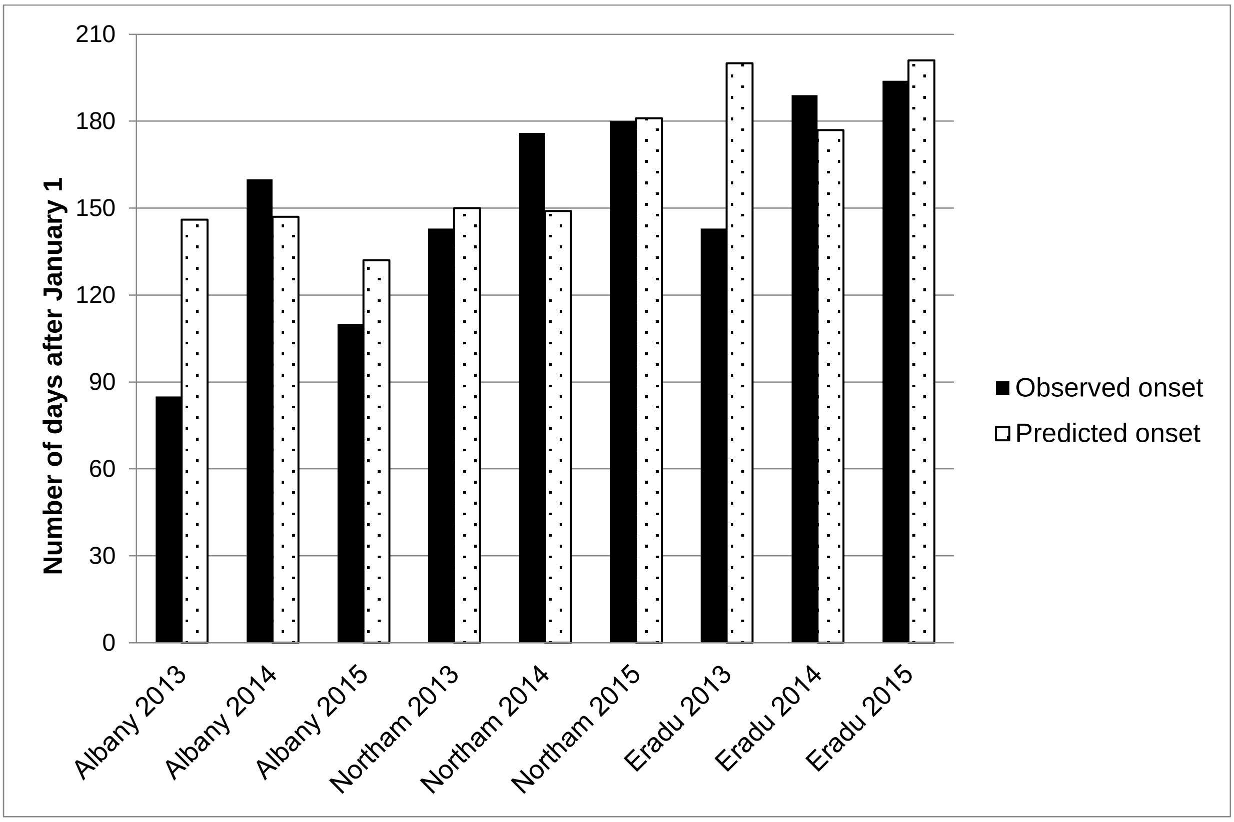


Figure 2. Observed time of onset of maturity and the predicted time of onset of maturity of yellow spot fruiting bodies at Albany, Northam and Eradu in Western Australia from 2013 to 2015.

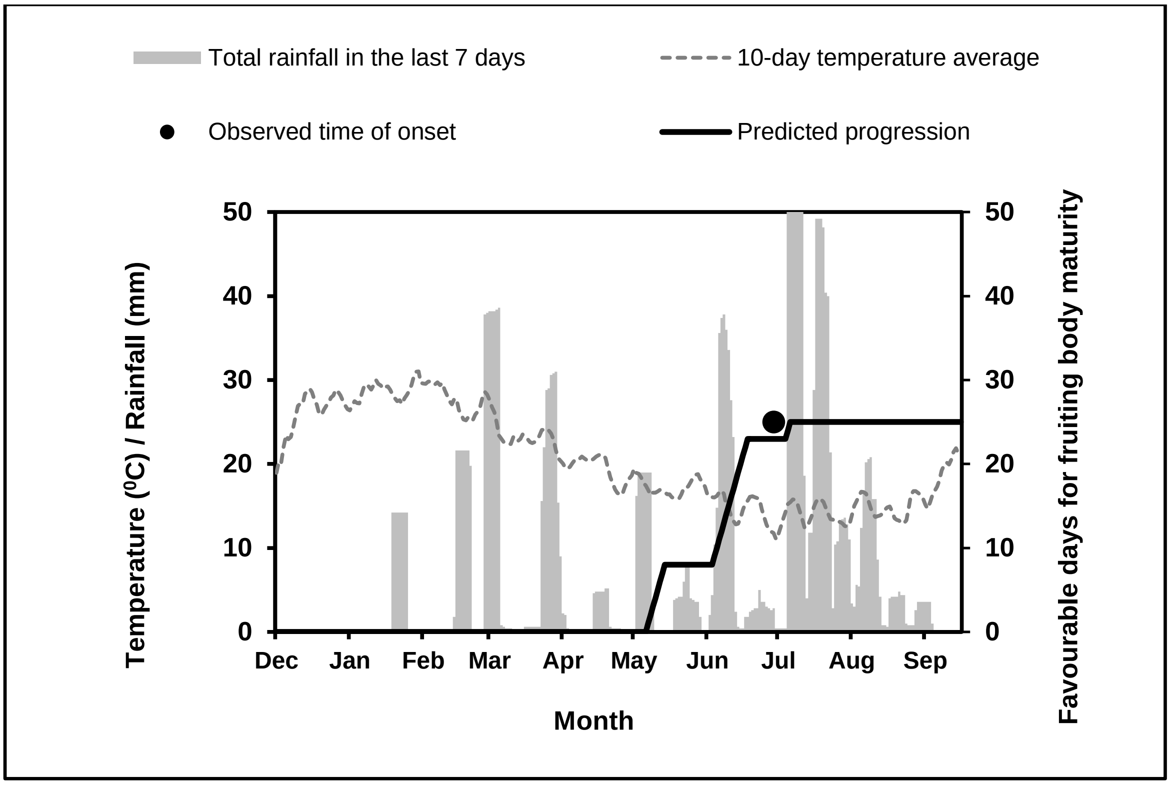


Figure 3. An example of the yellow spot spore maturity model output. The observed time of onset and the predicted time of onset for Eradu in 2015 are within seven days of each other. Note the predicted progression 'flat lines' after the onset of maturation in the spore maturity model as this is the point at which this model will interface with the secondary spread model.

The model predicted late May – late June maturation for Northam and late June – mid July maturation for Eradu. At both these locations in two out of the three years the predicted maturation was less than 14 days later than observed spore maturity and was rated as acceptable (Figure 2). In three of these location/years the level of accuracy of prediction was exceptional with predicted onset and observed onset having a deviation of 7 days or less. An example of this is given in Figure 3 which shows the model output for Eradu in 2015.

Conclusion

Based on the data presented here and on data from experiments conducted prior to 2013 it is apparent that yellow spot spore maturation occurs earlier in the southern cropping areas of the WA Grainbelt (Albany) compared with the central and northern cropping areas. Maturation onset at Albany generally occurs in April or May but has ranged from late March through to early June depending on the summer and autumn weather conditions. For growers in these southern cropping areas in some years it may be possible to avoid the yellow spot ascospores released from stubble by delaying sowing into wheat on wheat paddocks to avoid primary infection. There is currently no way of identifying those years with early maturation in which delayed sowing might be an option. We are hoping to be able to provide a decision support tool that will help growers identify years in which delayed sowing is an option for wheat on wheat in the southern cropping areas of Albany and Esperance. In the central and northern cropping areas yellow spot spore maturation occurs post sowing and there is no option for delayed sowing to avoid primary infection.

The spore release model predicted to within 14 days of observed maturity for the central (Northam) and northern (Eradu) locations in two out of three validation seasons and one out of three seasons in Albany. In two locations in 2013 (Albany and Eradu) the prediction was a lot later than the actual observed maturity. This is most probably due to the duration of wetness parameters used in the model not being sufficiently refined. Some refined parameters on wetness duration will be used to adjust (calibrated) the model. It is anticipated that the refinements added to improve prediction accuracy for Albany 2013 and Eradu 2013 will also improve the prediction levels for the other validation locations and years too. We aim to calibrate the model so that the model's prediction narrows down to within one week of the observed date of onset of maturity.

A generic fungicide decision support tool is being developed that will provide the economic potential for a wheat crop based on location, variety and cost of intervention (fungicide application). This generic decision support tool will be linked to the yellow spot ascospore model described here and a yellow spot secondary spread model that is currently in development.

Key words

Yellow spot, wheat, decision support tool, model

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