# Fungicides at seeding for management of cereal foliar diseases: powdery mildew in wheat

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## Key messages

* Systemic seed dressing or in-furrow fungicides are applied preventatively (prophylactically) to address potential disease risk. They can delay onset, reduce severity or eliminate occurrence of disease often resulting in significant yield responses. In the absence of disease however, they are unlikely to provide yield or economic benefit.
* In four field experiments in at-risk environments in 2016, wheat powdery mildew was evident at three sites and reached yield limiting severity at one site.
* At two sites where powdery mildew infection commenced during stem elongation, seed dressings containing fluquinconazole, triadimenol or fluxapyroxad and in-furrow products containing flutriafol, triadimefon or azoxystrobin had significant impact on disease severity and incidence. Product differences were evident between sites.
* At the one site where powdery mildew was yield limiting, in-furrow and foliar fungicide treatments gave a significant yield response in a susceptible wheat variety.
* In three of four sites where disease severity was not yield limiting, neither foliar, seed dressing or in-furrow fungicides provided a yield response and would not have given positive return on investment.

## Background and Aims

Powdery mildew (PM) has become more prevalent in WA wheat crops in recent years and was particularly widespread and damaging in several regions in 2015. A major concern for wheat producers is the susceptibility of several popular varieties, the time of onset of disease requiring early intervention in the cropping season and subsequent concerns over requirements for multiple foliar applications. Trial results from 2015 (Beard et al, 2016) clearly indicate that foliar fungicides can provide effective disease control and subsequent economic returns through reducing yield loss. Anecdotal reports from 2015 indicated that some systemic seed and fertiliser applied fungicides, registered in wheat for a range of fungal diseases, were delaying the onset of wheat powdery mildew. This paper describes results from trials at a range of locations, investigating the efficacy of seed dressing and fertiliser applied fungicides on the time of onset, rate of development and yield impact of wheat powdery mildew.

## Method

Field trials established at five sites in 2016 were designed to evaluate the efficacy of seed, fertiliser and foliar applied fungicide on the severity and yield impact of wheat foliar diseases including PM. Sites were established with susceptible varieties at: Geraldton (WyalkatchemPBR symbol), Dalwallinu (CorackPBR symbol), Moora (CorackPBR symbol), Tambellup (MacePBR symbol) and Gibson (SceptrePBR symbol). The Gibson site was abandoned due to waterlogging. Dalwallinu, Tambellup and Moora sites were established on canola or lupin stubbles while the Geraldton site was established on wheat stubble from a PM infected crop in 2015. All sites were sown into moist soil between 4th and 11th May.  
Fungicide products reported in this paper include; seed dressings fluxapyroxad (Systiva® 150mL/100kg seed), triadimenol (Baytan T® 150mL/100kg seed), fluquinconazole (Jockey Stayer® 450mL/100kg seed); in-furrow coated on granular fertiliser flutriafol (Flutriafol 250® 400mL/ha), azoxystrobin + metalaxyl-M (Uniform® 400mL/ha), triadimefon (Triadimefon 500 Dry® 200g/ha), and foliar propiconazole (Tilt® 250EC 250-500mL/ha) and prothioconazole + tebuconazole (Prosaro® 420SC 150-300mL/ha) applied at Z30-31, Z39-45 or Z55, with appropriate water rates and adjuvants as per label recommendations.

Disease severity was assessed regularly through the growing season by estimating leaf area affected by foliar disease symptoms on the top three or four fully expanded leaves of at least ten randomly selected plants per plot. Where multiple diseases were present, area affected was assigned to each disease. Where disease was present on stems or heads, incidence and severity of symptoms were recorded. Yield was determined by machine harvest and grain quality parameters assessed, including hectolitre weight, thousand grain weight, protein and screenings (2.0mm screen).

Disease severity and yield responses were analysed by ANOVA. Spatial trends were evident in responses at the Geraldton site and REML analysis was carried out for this site.

## Results

Triadimenol seed treatment significantly reduced seedling establishment by 14-26% across all sites. Powdery mildew occurred at three of four sites, however despite all sites using varieties that were susceptible to this disease, Geraldton was the only location at which infection was severe enough to cause yield loss.

*Geraldton*: Seed dressing, in-furrow or foliar fungicides were applied as stand-alone treatments and due to limitations of experimental space multiple application treatments were not included. Powdery mildew was evident in untreated plots in early July (~Z31/32), approximately nine weeks after sowing and one week after first foliar application. At this time the average severity of foliar disease infection across the top 4 leaves was 0.6% PM and 2.4% yellow spot. Powdery mildew developed rapidly and all treatments significantly reduced disease incidence and severity (Figure 1). Powdery mildew infection rapidly diminished from the beginning of September while septoria nodorum blotch became evident at low severity on upper canopy leaves and some glumes.

Spatial analysis (using REML) revealed significant treatment yield responses (Table 2) and ANOVA revealed significant grain quality responses to fungicide treatments (data not presented). Yield responses greater than 13% (0.6t/ha) were significant, effective treatments included all foliar fungicide timings and fertiliser applied flutriafol and azoxystrobin.

Seed, fertiliser and foliar applied fungicides reduced average levels of powdery mildew on the top 3 leaves on Wyalkatchem Wheat at Geraldton in 2016. Mildew was first detected at the site in early July when the plants were at Z31 growth stage and disease climbed to 23 percent on the top three leaves of the untreated plots by 24 August, Z71 growth stage. The most effective treatment at the site for disease control was Flutriafol in-furrow which kept disease levels down to 2% over the same period. The other treatments ranged in disease level from 3-12% on the top 3 leaves when last assessed on 24 August, plants at Z71 growth stage.

**Figure 1. Effect of seed (SD), fertiliser (IF) and foliar applied fungicides on powdery mildew disease progress (average % leaf area diseased by powdery mildew on top 3 leaves) on Wyalkatchem**PBR symbol **wheat at Geraldton. Mildew first detected in early July at Z31/32 (Bar=Lsd at each assessment time).**

*Dalwallinu*: Powdery mildew became apparent on 7th July (~Z30), approximately nine weeks after sowing. Infection incidence increased slowly for six weeks reaching 90% of plants affected but at a severity of less than 5% average leaf area affected (top 3 leaves). Fluquinconazole and triadimenol seed dressings and flutriafol in-furrow application delayed the development and spread of PM (Table 1). Prosaro® foliar fungicide applied at stem extension (Z30) as disease became apparent also significantly delayed development of infection. PM incidence and severity diminished rapidly by flowering and there was no disease response to the foliar fungicide applied at booting.

Flag smut, arising from soil borne inoculum, occurred in 0.8% of plants in untreated control plots. Seed treatment (fluxapyroxad, triadimenol, fluquinconazole) completely controlled infection (0%) and in-furrow fungicides reduced flag smut incidence (flutriafol 0.2%, Triadimefon 0.2%, azoxystrobin 0.6%), but not as successfully as seed dressings. Foliar application of Prosaro® had no effect on flag smut incidence (0.8%).

In the absence of yield limiting levels of powdery mildew or other foliar diseases, neither seed dressing, in-furrow nor foliar applied fungicides had an impact on grain yield or quality at Dalwallinu (Table 2).

**Table 1: Effect of fungicide treatments on incidence of powdery mildew in Corack**PBR symbol **wheat at Dalwallinu in 2016. Mildew first detected at trace levels on 7th July (~Z30).**

|  |  |  |  |
| --- | --- | --- | --- |
| Fungicide treatment | Incidence of powdery mildew (% plants affected) | | |
|  | 21-Jul Z37 | 4-Aug Z45 | 17-Aug  Z55 |
| Untreated | 70 | 77 | 90 |
| Fluquinconazole (SD) | 25 | 51 | 67 |
| Fluxapyroxad (SD) | 70 | 69 | 77 |
| Triadimenol (SD) | 10 | 40 | 60 |
| Flutriafol (IF) | 5 | 51 | 53 |
| Triadimefon (IF) | 25 | 47 | 73 |
| Azoxystrobin+metalaxyl (IF) | 65 | 80 | 65 |
| Prosaro® 150ml -Z30 | 5 | 38 | 47 |
| Prosaro® 150mL –Z45 | - | - | 47 |
|  |  |  |  |
| p-value | 0.063 | 0.012 | 0.002 |
| Lsd (5%) | 51 | 23 | 19 |

Note: SD = seed dressing, IF = coated on fertiliser applied in-furrow

*Moora*: Powdery mildew became apparent at trace levels at booting (~Z45), however disease development was slow and average severity in untreated controls was <1% leaf area affected, with infection primarily restricted to Flag-2.   
At-seeding and Z31 treatments had minimal effect on either incidence or severity of PM infection at any stage. Approximately 10% of untreated control plants had some level of head infection, Prosaro® applied at Z39 was the only treatment to significantly influence incidence of head infection.

Septoria nodorum blotch was present at low levels throughout the season, assessments at ~Z55 showed a small but significant effect of both foliar treatments and flutriafol and triadimefon in-furrow on necrotic leaf area. With late onset of PM and low severity of septoria nodorum blotch, yield and grain quality were not significantly improved by fungicide treatments (Table 2). This was the only site at which reduced emergence in triadimenol treated plots resulted in a negative yield response (-15%).

*Tambellup*: Powdery mildew did not occur at this site. In the absence of any significant foliar fungal disease infection, there was no difference in green leaf area retention and no subsequent yield impacts (Table 2).

**Table 2: Effect of seed dressing, in-furrow and foliar applied fungicides on yield of wheat at Geraldton (WyalkatchemPBR symbol), Dalwallinu (CorackPBR symbol), Moora (CorackPBR symbol) and Tambellup (MacePBR symbol) in 2016.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Fungicide | Grain yield (t/ha) | | | |
|  | Geraldton# | Dalwallinu | Moora | Tambellup |
| Untreated | 4.6 (100) | 2.7 | 4.5 | 5.0 |
| Fluquinconazole (SD) | 5.2 (113) | 2.8 | 4.4 | 5.0 |
| Fluxapyroxad (SD) | 5.2 (113) | 2.8 | 4.4 | 4.8 |
| Triadimenol (SD) | 5.2 (113) | 2.6 | 3.8 | 5.0 |
| Flutriafol (IF) | 5.8 (126) | 2.7 | 4.8 | 5.0 |
| Triadimefon (IF) | 5.2 (113) | 2.7 | 4.6 | 4.8 |
| Azoxystrobin+metalaxyl (IF) | 5.3 (115) | 2.8 | 4.6 | 4.7 |
| Tilt® or Prosaro® @Z30/31\* | 5.4 (117) | 2.6 | 4.4 | 4.9 |
| Prosaro® @Z39/45 | 5.5 (120) | 2.7 | 4.5 | 4.9 |
| Prosaro® @Z55 | 6.0 (130) | - | - | - |
|  |  |  |  |  |
| p-value | \* | ns | 0.009 | ns |
| Lsd (5%) | 0.7 | 0.21 | 0.38 | 0.46 |

Note: SD = seed dressing, IF = coated on fertiliser applied in-furrow   
\* Tilt 250EC® at Geraldton, Prosaro® at Dalwallinu, Moora, Tambellup  
# Yield as % of Untreated control

## Conclusion

A range of seed dressing and in-furrow products are registered in wheat for diseases including smuts and bunts, rhizoctonia root rot, wheat rusts, yellow spot and septoria tritici but none are currently registered for powdery mildew. All products tested in these trials are registered for use in wheat and there is great interest to see how they influence powdery mildew development. These products are currently used prophylactically to address a wide range of disease risks. When disease occurs they can delay disease onset and reduce or eliminate the need for foliar applications but with low disease severity they are unlikely to provide yield benefit. The benefit of systemic fungicides applied at seeding is through the fungicide being available in newly emerging leaves, providing a continuous source of protection. The length of protection varies between products, rates and diseases encountered.

All products tested reduced incidence and severity of PM at the Geraldton site resulting in at least 0.6t/ha yield response. At this site with disease occurring during stem extension and conditions favouring disease development, the at-seeding treatments provided similar benefit as foliar applications at Z31 or Z39. Greater response may have been evident if at-seeding treatments had been followed by foliar applications.

Similarly at Dalwallinu where PM occurred during stem extension, at-seeding treatments and a foliar application at Z30 delayed development of disease, however at this site environmental conditions were not conducive for continuing disease development, disease severity was low and the epidemic diminished naturally by flowering.

At two of four sites, at-seeding fungicides were demonstrated to have a significant effect on PM development and at only one of four sites was a significant yield response measured. Consequently at only one site, Geraldton, was there a positive return on investment from fungicides applied at-seeding. However at the Dalwallinu site, some of the treatments applied at-seeding provided a delay of disease development until at least flag leaf emergence which may have prompted a decision to not apply a foliar fungicide at this time, potentially saving an in-season investment.

Differences between products were apparent both in disease limitation and in subsequent yield response. Yield in all fungicide treatments at Geraldton was at least 13% greater than the untreated, with flutriafol and azoxystrobin+metalaxyl applied in-furrow providing significant yield responses while also providing lasting protection from disease. At Dalwallinu, flutriafol in-furrow and triadimenol and fluquinconazole seed dressing provided greatest delay in disease build-up.

Some care and awareness of risks associated with fungicide resistance should be employed in utilisation of these products, particularly for powdery mildew. Despite being applied prior to crop growth, seed dressing and in-furrow fungicides are the first application in a seasonal fungicide program and therefore subsequent foliar fungicide choice and fungicide group rotation needs to account for the active ingredient used.

The seed dressing and in-furrow fungicide ingredients applied in these trials can delay or reduce PM infection at the rates tested. Where PM infection becomes severe they can provide a yield response, particularly if disease occurs at early growth stages such as during stem extension. In the absence of diseases that are affected by these products, or when infection is not severe then yield responses and positive return on investment may not occur.

**Disclaimer**: We are reporting on seed dressing / in-furrow fungicide products that are registered for this use pattern in wheat but not currently registered for powdery mildew control, these products were tested in research experiments and results are presented here for scientific audiences. We do not make a recommendation for use of these products for powdery mildew control as they are currently not registered for this purpose.

## Key words

Wheat, seed dressing fungicide, In-furrow fungicide, powdery mildew

## References

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**Reviewer:** Jean Galloway (DAFWA)

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