# GRDC PODCAST TRANSCRIPT

**AFREN podcast – rusts and managing rusts with fungicides**

[00:00:02] **Intro** This podcast is brought to you by the Australian Fungicide Resistance Extension Network.

[00:00:10] **Drew Radford** Hello and welcome to the Australian Fungicide Resistance Extension Network Podcast. I'm Drew Radford and, in this episode, we're going to talk about rusts and managing rusts with fungicides. Until now there have been very few cases of fungicide insensitivity in rusts. However, research led by Professor Robert Park at the University of Sydney has shown insensitivities in the barley and wheat leaf rust pathogens to Group 3 DMI fungicides. To provide us with more insight on this, Professor Park joins us for this AFREN podcast. Robert, thank you for your time. Oh, thank you for the opportunity to speak to you. Robert, your area of expertise is cereal rusts. Can you though just take a bit of a step back and provide a bit of an overview on what rust is and why it's such an important and worrying disease in Australian cropping?

[00:01:10] **Robert Park** Yeah, well look, the rusts are caused by fungal pathogens. You can think of almost any plant species and it'll have a rust pathogen that infects it, but they're highly host specific. So there are wheat rusts, they obviously infect wheat, there are barley rusts that infect barley and there are oat rusts that infect oats. And very rarely do we see those rust pathogens infecting other crops. Now the reason they're particularly damaging is that they can build up really, really quickly. They've got enormous epidemic potential. So once they get into a wheat crop, into a susceptible variety, under favourable conditions, they can build up really, really quickly. The other thing that makes them particularly dangerous is that they spread across huge distances on wind currents very, very quickly. So we've heard examples of a new rust isolate appearing in eastern Australia, for example, and within a year and a half, it's been present in all Australian wheat growing areas. So, these things spread around really, really quickly and they build up rapidly in susceptible varieties.

[00:02:08] **Drew Radford** The ability to spread like that is highly disturbing and also the yield losses are quite substantial I understand.

[00:02:14] **Robert Park** They are indeed, yes. So, if you take wheat rust for example, there are three different rust pathogens that infect wheat causing three different diseases. One is called stem rust. Stem rust fortunately we don't see much of at all in Australia. It's been a terrific success story in resistance breeding so we don't see that much at all and that's very very fortunate because it causes total crop loss it'll kill a wheat crop. When you come to leaf rust, it can cause yield losses of up to 50 to 60 per cent; and then stripe rust which most of your listeners would be aware of very widespread last year in eastern Australia 60 to 70 per cent in yield loss in severe cases.

[00:02:52] **Drew Radford** Those are disturbing figures to say the least and a lot of money is spent in terms of fungicides to stop it?

[00:03:00] **Robert Park** Oh yeah, absolutely. I mean, I've been working on rusts for about 38 years now, hard to believe. If you go back about 40, 45 years, it was hard to find a wheat grower in Australia that actually used a fungicide. These days it's hard to find one that doesn't. Significant investments are made in fungicides, not to control just rust but other diseases as well. But when we have a year like we did last year where stripe rust was just extensive throughout eastern Australia and conditions were so conducive to disease development, a lot of growers used fungicides. Difficult to put a dollar value on that, but we do know from about 20 years ago, we had some figures in New South Wales, I think, of about $50 million being spent on fungicides in one year just to control stripe rust in wheat.

[00:03:47] **Drew Radford** Now your work has typically focused on looking at the rust pathogens and how they evolve and in turn looking at the genetics of resistance to those pathogens. Can you just briefly explain what that's involved?

[00:04:02] **Robert Park** These are damaging diseases. They're really, really dangerous and damaging diseases and they have caused significant yield loss and added costs to Australian grain production through the need for fungicide intervention. But we're very fortunate that in most of these crops there is really good genetic resistance. So that's evolved over time as these plants have evolved in their centre of origin. They've evolved with these rust pathogens and so they've evolved resistance mechanisms. Breeders have been able to go back and tap into that and incorporate those genetic resistant mechanisms into new varieties. So those high yielding new varieties when they're released carry those genes for resistance and you know if those genes are working well and the pathogen hasn't found a way to get around them, then there's no need in many cases to actually apply a fungicide to control the rust.

[00:04:53] **Drew Radford** Which is the ultimate objective, but as you know we're recording this podcast for the Australian Fungicide Resistance Extension Network, so let's talk fungicides.

[00:05:04] **Robert Park** So we can use this genetic resistance and all going well, it will provide complete protection against rust and there's no need for any fungicide intervention. But what we see quite often is that the resistance that's being put into varieties is not complete. So, you end up with varieties that carry a resistance known as adult plant resistance. You get some protection from rust, but not complete protection from rust. And in those cases, you can get an economic return from applying a fungicide. So many growers will actually balance, or let's say use an integrated approach where they use fungicides and resistance.

[00:05:40] **Drew Radford** It sounds like the ideal mix there to deal with it, but obviously you're concerned that that may not be enough down the track. So is that why there's research into fungicide resistance in the rusts?

[00:05:52] **Robert Park** I guess there are two reasons really. I mean, one is quantifying losses associated with different levels of resistance. And that's very important. If a grower is, has a variety that is moderately susceptible to rust, then you will get visible amounts of rust in a crop. The question then is how much yield is going to be lost due to that? So quantifying that then allows far more informed decisions to be made around the use of fungicide intervention and then the economic return that will be gained from doing that. So there's sort of a really important aspect there in combining genetic resistance with fungicides in determining the economics, I suppose, of applying a fungicide to a variety with an intermediate level of resistance. And that's one of the most common questions I'm asked by growers is that I have a variety, it has an intermediate level of resistance, should I apply a fungicide? And to answer that question, we really do need that information on yield loss, and then we can determine the value of that yield potential of the crop, and from that, you know, the likely economic return from a fungicide application. So that's one of the really important reasons that we're doing this research. But the other, of course, is to ensure we don't end up in a situation like we've seen with many of the other foliar pathogens, things like mildew, septoria, yellow spot, that have developed resistance or insensitivity to fungicides. This is really important. What it means is that if you have one of those diseases in a wheat crop and you apply a fungicide, you're not going to control it because the pathogen is insensitive or resistant to it.

[00:7:25] **Drew Radford** Well, you mentioned there the research that you were doing. Can you just give us a bit of a broad brush stroke of what that's involved? I understand, you know, 800 rust isolates of wheat you've tested. There's a bit going on.

[00:07:37] **Robert Park** So what we've been doing for many, many, years now going right back to 1921, so this is more than 100 years at the University of Sydney, we've been monitoring these serial rust pathogens across Australia for virulence. So, this is their ability to overcome resistance and every now and then we find a new strain that can overcome the resistance of a variety and the variety goes from being resistant to susceptible. So that information is really important in breeding for genetic resistance and also in the post-release management of varieties. About 10 years ago, we were approached by GRDC and asked if we could start monitoring not just the virulence but the fungicide response, sensitivity, insensitivity of rust isolates, of these rust isolates we were receiving for strain analysis. So, you mentioned 800 isolates, quite a lot of work. In a given year for virulence analysis, we can receive anything from 200 to 300 samples up to 1,000. I think last year we received almost 1,000. And out of those, we take a sub-sample that we test for their response to fungicides. And so far, as you mentioned, we've looked at about 800 of these isolates.

[00:08:47] **Drew Radford** Which is a remarkable number to say the least, but you've also found some resistance concerns within that.

[00:08:52] **Robert Park** Well, yeah, it was a real surprise to me. I actually did some of this work many years ago, back in 1995 in Europe. I worked in a laboratory that was doing routine fungicide insensitivity screening on European isolates of particularly powdery mildew. And I did some work on leaf rust over there and we found a little bit of evidence of insensitivity, not much, just a little bit. So I didn't really expect to find much when we were looking in Australia. But it didn't take us long and we found a marked shift to insensitivity in the leaf rust pathogen of wheat and in the leaf rust pathogen of barley.

[00:09:26] **Drew Radford** That's obviously a concern. I understand also this particular lineage that you found that the insensitivity rates were more than six times the recommended application rate of 290 millilitres per hectare.

[00:09:39] **Robert Park** That's right, so even exceeding in multiples a high recommended field rate. Now I should stress that this work has been done in our greenhouse system. We test intact plants, so we actually grow seedlings of a susceptible cereal. We then apply a defined rate of fungicide to those seedlings, and then a day later we challenge them with a rust isolate. These are tests that are done on intact plants, and we've been able to show differences, very, very big differences between historic isolates that were collected 30, 40, 50 years ago, and some of these ones that are getting around these days. What we've not done, and I think this is a very important point to make, what we've not done is connected that with what's going on in the field. So, there've been no reports of field failure of these fungicides in controlling rust in commercial crops. But we certainly found very convincing evidence of this under control conditions. And as you say, at multiples of the high field rate.

[00:10:42] **Drew Radford** I think we should also be really clear that these are a select group of barley and wheat leaf rust pathogens specifically to group three DMI fungicides.

[00:10:54] **Robert Park** That's correct. I mean, it's very interesting actually that, um, that we've turned this up. I guess I could go back one step and say these pathogens in Australia, if we're talking about wheat leaf rust, it is a clonal. It only undergoes asexual recombination and an asexual reproduction. There's no sexual recombination that goes on here. So, what happens is often we see a trait like this fungicide insensitivity, and it sort of stays in one group of isolates or one family, if you like. Now in the case of the wheat leaf rust, we've actually traced that back through our historic isolates and shown that that was actually an exotic incursion. So that insensitivity to the to the DMI fungicide did not evolve in Australia. It came from somewhere overseas when this isolate came in, I think it was in 2017 when it came into Australia. And interestingly, we found the same thing in leaf rust of barley. We keep viable isolates of all of these rusts in liquid nitrogen. And we've got them going back 50, 60 years. So, when we found this insensitivity in leaf rust of barley, we were able to, in field collected samples of leaf rust of barley, we were able to go back into our historic collection right back to the very original isolate that we found of that strain in 2001, and it was insensitive. So, we have two examples, leaf rust on wheat and leaf rust on barley, specific strains within those pathogens that carry the insensitivity, and in both cases, they were exotic incursions, so the insensitivity did not arise in Australia.

[00:12:32] **Drew Radford** That's really important information to note because fundamentally this is not causing undue concern for growers and growers are the central focus to this. And you mentioned earlier that you were testing, were showing that resistance to repeated applications in greenhouses. So what does this research then mean for growers? What special considerations need to be made when selecting fungicides to apply?

[00:12:57] **Robert Park** We can say that there are some fungicides that do work against these insensitive isolates. These are the strobilurin DMI mixtures. They're more expensive, but we do know they work. I suppose that's one important piece of information. But I think the really, really critical issue here is for us to get people who are growing barley and growing wheat and who have leaf rust in those crops and who are using fungicides to let us know so that we can actually monitor that very closely. We want to know whether or not those fungicide applications are working. And if they're not, that has, I suppose, vindicated our results and shown that we've got field failure. And then we can make specific recommendations on these strobilurin DMI mixes.

[00:13:40] **Drew Radford** It's important to know that primary producers need to be considered as part of the feedback loop and are fundamental to the work that you're doing.

[00:13:47] **Robert Park** Oh look, absolutely. With our nationwide rust surveillance efforts, we receive up to a thousand samples a year for strain analysis. They all come from growers and from agronomists and people with their feet on the ground out in the industry. So, this is very much a citizen science effort, if you like. It's been going on for a long, long time. Without those people being involved and submitting those samples, and not just submitting the samples, but sending in information: what variety of the samples come off, growth stage, location, the history of how the crop has been managed, whether a fungicide has been applied on, all that is really, really important information for the surveillance to be successful. It just doesn't work without that.

[00:14:24] **Drew Radford** And as part of this mix, do growers need to consider the use of Group 3 DMIs?

[00:14:29] **Robert Park** What we really need to know is whether what we've found is true field failure of these fungicides. There's not been any reports coming to us of failure of fungicides to control leaf rust in wheat or failure of fungicides to control leaf rust in barley. We've had anecdotal reports, but no specific reports. So, we really need to make that connection before people become too concerned about it. What does concern me about it, with the information we have at this point, is that we've got very, very clear evidence under greenhouse control conditions of a huge shift to insensitivity in two rust pathogens. There's really been no examples of this reported elsewhere in the world. There have been reports of insensitivity of Asian soybean rust to fungicides in South America and one or two others. But what we've seen is a wholesale shift to insensitivity. And in fact, in one of these pathogens, we've actually been able to find a genetic anomaly, a change in the genome of the pathogen associated with that insensitivity, which makes me believe that what we're seeing is something that's real and something that will have impact in agriculture. The concerning thing about that is that, you know, for many years, people have said that the rust pathogens really are less prone and maybe can't evolve in sensitive to fungicides. But our results pretty much saying that they can.

[00:15:58] **Drew Radford** Robert, what about non-chemical methods of avoiding rusts on farm? Can you please outline the strategies growers need to consider?

[00:16:08] **Robert Park** Look, that's a really good question. The fact is that controlling rust in crops needs to be based on genetics. So that needs to be the foundation of any really effective control measures. So you need to be very careful in varietal selection and make sure your variety has a level of resistance. There are other methods that can be used. Clearly, fungicides is one of those. Managing intermediate levels of resistance where small amounts of disease can develop with chemical intervention has been very, very effective and many growers have become very skilled at doing that. So that's an integrated genetics and fungicide approach if you like. In addition to that, there are two very other important things. One is not to grow highly susceptible varieties. Rusts are what we call social diseases. The spores blow around on wind over large distances. So, what happens on one farm can have an impact on neighbouring properties. So it's important to avoid those highly susceptible rust varieties. The other important pillar of the integrated rust control package is to control the green bridge. So, these rust pathogens, unlike many other pathogens that survive on dead tissue and are stubble-borne, the rusts are not like that. They need living host tissue in order to survive and that means during the summer months, the non-cropping phase, they find it very, very hard to survive because obviously there's no crops out there. They do survive on self-sown cereals. So if there's rainfall events during summer and autumn, we see establishment of self-sown cereals and the rust will survive on those and build up. And that's what we call the green bridge. It's this self-sown cereals that can emerge in the traditional non-cropping summer period of time. And really important to destroy that green bridge either through a herbicide application or through grazing.

[00:18:02] **Drew Radford** So Robert, under the Fungicide Resistance Five, are there any other points you think growers should consider?

[00:18:06] **Robert Park** Oh yeah, look, I think there are three other points that I could mention. One is the importance of rotating crops, important to avoid wheat on wheat, to limit the build-up of disease pressure from year to year. Now that is a bigger point when it comes to the necrotrophic pathogens that survive on dead tissue, but it can also have an impact on things like the rusts if that gives rise to increased green bridging. Second point is to spray only if necessary, and really the timing of those sprays is critical in order for them to really be effective in controlling rust. It's even more tricky when you're using resistance that is expressed at post seedling growth stages. So getting that timing right at the right growth stage is really, really important. And then the final point I would make is the mixing and rotating of fungicides. If you're looking at the whole spectrum here, and most growers do, it's not just about controlling rust, it's about controlling other diseases. So, you really need to consider potential insensitivity to chemicals in those other pathogens as well.

[00:19:07] **Drew Radford** Robert, wonderful insights, and thank you so much for your time. Professor Robert Park from the University of Sydney, thank you very much for joining us for this AFREN podcast.

[00:19:18] **Robert Park** My absolute pleasure. Thank you so much for the opportunity to talk to you.

[00:19:27] **Drew Radford** If you want easy access to more fungicide resistance resources, visit the Australian Fungicide Resistance Extension Network website at afren.com.au. AFREN is a significant investment of the Grains Research and Development Corporation and has produced a Fungicide Resistance Management Guide, fact sheets, recorded webinars, videos and of course, this podcast series. You'll find them all at afren.com.au. I'm Drew Radford, thanks for joining me.