Fungicide control of Rhizoctonia Part B
Syngenta

Summary
Data from 21 field trials conducted across South Australia (SA) and Western Australia (WA) were obtained to support an application by Syngenta to the Australian Pesticides and Veterinary Medicines Authority (APVMA) to register banding of the fungicide Uniform® to control rhizoctonia root rot in wheat and barley. The APVMA is currently considering the application.

Across all trials, using liquid systems to dual band 150 or 200ml/ha of Uniform® below the seed and behind the press wheels (total 300 and 400ml/ha, respectively) produced the greatest proportion of significant yield responses (14/19), followed by banding 300 and 400ml/ha below the seed (22/33), then a combination of banding 200ml/ha of Uniform® below the seed plus the seed dressing Vibrance™ at 360mL/100kg seed (11/21), followed by Vibrance™ seed treatment alone (4/21 trials).

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Conclusions
Syngenta has applied to the APVMA to register Uniform®# (SYNSIF1) to control rhizoctonia root rot in cereal. If this application is successful, Uniform® will provide growers with a new management tool to provide significantly more consistent and greater yield improvements than result from use of the seed treatment Vibrance™# at 360mL/100kg seed alone.

Meta analysis of data from the 21 field trials conducted from 2011 to 2013 across SA and WA show the best treatment was to dual band Uniform® at 200mL/ha below the seed and on the soil surface behind the press wheels (total 400mL/ha). The results achieved with this rate were not significantly different from banding 150mL at each location but were significantly better than banding Uniform® at 200mL/ha in-furrow in combination with Vibrance™ seed treatment at 360mL/100g seed, or banding Uniform® alone at 300 or 400mL/ha below the seed. These treatments were significantly better than using only Vibrance™ at 360mL/110kg seed.

Results from banding Uniform® at 400mL/ha on the surface behind the press wheel were not significantly different from those in the dual banding treatments, however this treatment was evaluated in 2013 only, when good rainfall post seeding would have facilitated movement of the fungicide into the root zone. Efficacy may not have been as good in a season with less rainfall post seeding.

Root health assessments show that the dual banding of Uniform® improved the health of the crown and seminal roots. Banding in-furrow alone improved health of the seminal roots but crown roots were not protected. Banding Uniform® below the seed in combination with use of Vibrance™ seed treatment improved the health of the crown roots. These trials were sown at 3cm. If the crop had been sown deeper, crown root protection would probably have been reduced.

Yield responses in barley and wheat were highly correlated and greater in barley. The visual effects of rhizoctonia root rot were more visual in barley. Losses in wheat are more likely to be undiagnosed because in wheat crops sown early, rhizoctonia root rot tends to cause reduced tillering and uneven crop growth from about mid winter, rather than the classic bare patches that growers typically associate with this disease.

Uniform® had some impact on the soil bacteria associated with nitrification early in the growing season. This could exacerbate nitrogen (N) deficiency at seeding in low N soils and possibly limit the benefit of using the fungicide.

Some beneficial soilborne fungi seemed to benefit from the application of Uniform®. Arbuscular mycorrhizal fungi (AMF) data showed a significant increase in AMF levels, most likely due to the increased root growth as measured by plant DNA concentration in soil. In general, there was very little treatment effect on total microbial activity and microbial biomass at 0-5cm and 5-10cm depths and no major treatment effects on total bacterial and fungal DNA levels. Banding the fungicide will limit any other potential adverse impacts Uniform® may have on soil biology that were not measured by this project.

**Recommendations**

Growers are recommended to consider:

- Using a liquid system to band Uniform®# to improve control of rhizoctonia root rot in wheat and barley.
- Setting up the liquid delivery system to apply half the fungicide rate at the base of the furrow and 3-4cm below the seed and the other half on the furrow surface behind the press wheel. Note that this entailed twice the volume of water applied per ha (e.g. 80L/ha at each location where this dual treatment was used in the trials).
- If only banding fungicide below the seed then consider increasing the seeding rate to help compensate for loss of tillers associated with rhizoctonia damage to the crown roots.
- Try to address other constraints such as compaction layers that restrict root growth down the soil profile.

Fungicide treatments should be used as part of an integrated management program to minimise the impact of rhizoctonia root rot, taking account the following:

- Non-cereals, especially grass free canola and pulses, provide a useful reduction in rhizoctonia levels for the following crop.
- Frequent summer rainfall combined with summer weed control will reduce rhizoctonia levels at seeding.
- Control any autumn ‘green bridge’ two to three weeks before seeding.
- Early sowing and soil disturbance below seed facilitate root growth down the soil profile.
- Knife point soil openers reduce the risk of rhizoctonia compared to discs.
- Consider increasing seeding rate to reduce the impact of tiller loss due to rhizoctonia damage to crown roots.
Nutrient stressed plants are more vulnerable, so ensure adequate nutrition; in particular minimise N deficiency by banding N below the seed and avoid incorporating stubble.

Address in-crop nutrient deficiencies with foliar application of relevant nutrients.

Outcomes

Economic Outcomes

Registration to band Uniform® + Uniform® # to control rhizoctonia root rot in wheat and barley will provide greater and more consistent yield responses than are achievable using seed treatments alone.

There was a strong correlation between yield responses for wheat and barley. Best yield increases were 0.22- 0.46t/ha for barley and 0.11- 0.32t/ha for wheat. These were achieved by banding Uniform® below the seed at a rate of 200mL/ha combined with 200mL/ha banded on the soil behind the press wheels. These increases were not statistically different from those achieved with Uniform® applied at 150mL/ha at the same locations or when only banded behind the press wheels at 400mL/ha.

Yield responses for Vibrance™ + Uniform® # 360mL/100kg seed averaged 0.07t/ha (4.6%) in wheat and 0.02t/ha (1.2%) in barley. Other treatments that yielded significantly better than seed treatment alone included Vibrance™ at 360mL/100kg seed plus Uniform® at 200mL/ha banded below the seed. This increased yield of barley 0.18t/ha (8.9%) and wheat 0.13t/ha (7.8%), respectively. Uniform® 300 and 400mL/ha banded below the seed increased yield of barley 0.21t/ha (10.4%) and 0.3t/ha (13.8%) and wheat 0.15t/ha (8%) and 0.17/ha (11.1%), respectively.

Banding fungicides is also compatible with precision agriculture, which means growers can target application of Uniform® to areas where it is most likely to provide an economic response.

Use of liquid delivery systems also eliminates the risk of contaminating trucks and grain elevators that can occur when fungicide is delivered via treated seed or coated fertiliser.

Environmental Outcomes

Uniform® applied above and below the seed protected the crown and seminal roots. Vibrance™ seed treatment (seed was sown shallow, 3cm) plus banding Uniform® below the seed also protected the crown roots. Deep banding Uniform® alone protected only the seminal root system. Greater root growth will support higher yields and increase carbon input into the soil.

The impact of Uniform® on soil biology was monitored at several sites in mid winter and late spring.

Uniform® significantly reduced levels of nitrifying bacteria (measured by amoA gene copy number/gram of soil) by mid winter but levels recovered later in the year. This group of bacteria has limited diversity and is known to be a sensitive indicator of agrochemical effects, especially from herbicides. Their reduction was reflected in a reduced nitrification rate and could exacerbate N deficiency in low N soils at seeding.

AMF levels increased significantly, most likely due to the increased root growth as measured by plant DNA concentration in soil.

In general, there were few treatment effects on total microbial activity and microbial biomass at 0-5cm and 5-10cm depths and no major treatment effects on total bacterial or fungal DNA levels.

Social Outcomes

Using liquid systems to band Uniform® should reduce risk of operators being exposed to fungicide compared with using treated seed and fungicide coated fertiliser.

Achievements/Benefits

Background

Rhizoctonia root rot of wheat and barley caused by Rhizoctonia solani AG-8 causes yield losses in southern and western Australia estimated to cost the industry up to $59 million per annum (Murray and Brennan, 2009 a and b). These losses are...
probably conservative because most affected paddocks do not exhibit the classic bare patches that growers normally associate with rhizoctonia.

In 2008, GRDC funded CSIRO to lead a new project CSE00048 ‘Better prediction and management of Rhizoctonia disease risk in cereals’ in the southern region with linkages to GRDC funded ‘In-furrow fungicide’ project DAW00152 in WA led by Bill McLeod (Department of Agriculture Food Western Australia (DAFWA)). Under CSE00048, the South Australian Research and Development Institute (SARDI) conducted several field trials to evaluate seed treatments to reduce the impact of rhizoctonia root rot. No significant yield responses were detected, which mirrored many grower experiences.

Some of the newer fungicides tested were known to have activity against \( R. \ solani \) AG-8. The 2008 trials were affected by drought, so the lack of yield responses may be due to lack of rain post sowing to move the fungicide off the seed and into the root zone. Another key observation was that rhizoctonia damage in crops sown deep was often restricted to the crown roots. Subsequent testing showed that most \( R. \ solani \) AG-8 inoculum was concentrated in the top 2.5cm of soil and that levels throughout the soil profile increased dramatically in the spring.

In 2010, the SA Grains Industry Trust (SAGIT) co-funded a project with Syngenta to evaluate banding fungicides at different locations above and below the seed. Above average rainfall in summer and autumn that year reduced rhizoctonia levels to 85 picograms (pg) DNA/gram of soil pre-sowing at the trial location in Ceranium. Above average rainfall continued throughout the season to produce record yields in the Murray Mallee. Despite the non-conducive conditions for rhizoctonia, a combined application of coded fungicides above and below the seed produced significant yield responses of 0.6t/ha or 12% greater than the untreated. Combined application of fungicides above and below the seed also significantly improved root health scores for the crown and seminal roots, while banding below the seed protected only the seminal roots.

In 2011, GRDC co-funded three new projects to develop use of fungicides to control rhizoctonia root rot. DAS00122 was co-funded by Bayer CropScience (research collaborators include SARDI, UniSA and DAFWA) and DAS00123 was co-funded with Syngenta (research collaborators SARDI, UniSA, DAFWA and CSIRO). The primary aim of these projects was to generate efficacy data to support registration by the APVMA to band fungicides to reduce yield losses caused by rhizoctonia root rot in cereals. A third GRDC project, DAS00125, co-funded by SAGIT provided funds to SARDI and UniSA to develop application methods.

**Project Achievements**

**Field program**

Syngenta decided early on to focus on developing a data package for Uniform\(^{®}\) (SYN SIF1) rather than Vibrance\(^{™}\), which was registered as a seed treatment for rhizoctonia control in 2013.

SARDI, UniSA, and DAFWA, with statistical support from Dr Ray Correll (RHO Environmetrics Pty Ltd), designed, conducted and analysed data from 21 trials (11 wheat and 10 barley) across 14 sites in SA and WA over three seasons from 2011 to 2013. Since rhizoctonia has a notoriously patchy distribution, a split plot design with half the plot untreated was used to evaluate all treatments.

Treatments included banding Uniform in-furrow 3-4cm below the seed, on the soil surface behind the press wheels and a combined split application with half the fungicide banded on the soil surface behind the press wheels and the other half in-furrow below the seed. Several rates were evaluated each year with rates increased over time because yield responses increased as rates were increased. A Uniform\(^{®}\) in-furrow treatment combined with the Vibrance\(^{™}\) seed treatment was also evaluated. Vibrance\(^{™}\) seed treatment was included as the industry standard.

**Yield response summary**

Meta analysis of the wheat and barley trials revealed 1) a strong correlation between treatment responses for wheat and barley, 2) barley was more responsive, and 3) significant treatment differences that were often not detected in individual trials.

In the meta analysis, Vibrance\(^{™}\) 360mL/100kg seed averaged 0.07t/ha (4.6%) in wheat and 0.02t/ha (1.2%) in barley. This compared to the best yield increases of 0.22-0.46t/ha for barley and 0.11-0.32t/ha for wheat obtained by banding Uniform\(^{®}\) below the seed at a rate of 200mL/ha plus 200mL/ha on the soil behind the press wheels. These yield increases were not statistically different from Uniform\(^{®}\) applied at 150mL/ha at the same locations or when Uniform\(^{®}\) at 400mL/ha was banded behind the press wheels. Note that the latter treatment was evaluated only in 2013 and may not perform as well in different seasons.
Other treatments that yielded significantly better than a seed treatment in the meta-analysis included Vibrance™ at 360mL/100kg seed plus Uniform® at 200m/ha banded below the seed. This combined treatment increased barley yield by 0.18t/ha (8.9%) and wheat by 0.13t/ha (7.8%), respectively. Uniform® at 300 and 400 mL/ha banded below the seed increased yield of barley by 0.21t/ha (10.4%) and 0.3t/ha (13.8%) and wheat by 0.15t/ha (8%) and 0.17t/ha (11.1%), respectively.

Root health response summary

Split application treatments of Uniform® resulted in the healthiest root systems, with crown and seminal roots in treated plots significantly healthier than in the untreated controls in almost all cases. Uniform® applied in furrow combined with Vibrance™ seed treatment also produced significantly healthier crown and seminal roots compared with the untreated. In this combined Uniform®-Vibrance treatment, Vibrance™ probably diffused laterally from the seed to be taken up by the crown roots. These trials were sown shallow, seed 3.5cm below the surface. Vibrance™ may not protect crown roots as well in crops that are sown deeper. The Uniform® in-furrow only treatments generally improved the health of the seminal roots but not the crown roots.

Soil health responses

The impact of Uniform® on soil biology was monitored at several sites in mid winter and late spring. By mid winter, Uniform® had significantly reduced the levels of nitrifying bacteria (as measured by amoA gene copy number/g soil), however levels did recover later in the year. This group of bacteria have a limited diversity and are known to be sensitive indicators of agrochemical effects, including herbicides. The reduction was reflected in reduced nitrification rates and this could exacerbate N deficiency at seeding in low N soils.

AMF data showed a significant increase in AMF levels, mostly likely due to the increased root growth as measured by plant DNA concentration in soil. In general, there were very little treatment effects on total microbial activity and microbial biomass at 0-5 cm and 5-10 cm depths and no major treatment effects on total bacterial and fungal DNA levels.

Individual site efficacy data

Individual reports for the 21 trials were sent to Syngenta. These reports contributed to the data package submitted by Syngenta to the APVMA to support label registration to band Uniform® to help control rhizoctonia root rot in wheat and barley.

The review process has progressed to full evaluation stage and formal approval is expected in October/November. Limited quantities of Uniform® are expected to be available for the 2015 cropping season, with availability increasing in subsequent years.

Benefits to the industry

Registration of Uniform® applied as a liquid band (especially as a split placement treatment above and below the seed) in cereal crops at risk from rhizoctonia root rot should produce more consistent and greater yield responses in wheat and barley crops than other fungicides applied as a seed treatment.

More than 50% of growers in WA already have liquid delivery systems on their seeders. Adoption of this technology has been much slower in the southern region, but interest in it for delivery of micronutrients is growing. Registration of fungicides such as Uniform® is expected to increase adoption of liquid delivery systems in the southern region.

Uniform® is not a silver bullet, and other constraints such as soil compaction, nutrient deficiency, etc, that contribute to the severity of rhizoctonia will need to be addressed to achieve best yield responses.

The liquid metering and banding technology used in the project was sponsored by Liquid Systems SA and TopCon Agriculture and offered a unique ability to apply accurate and even fungicide rates in all treated seed rows, delivered in a continuous stream for improved likelihood of access by each plant. Other benefits associated with using liquid delivery systems are 1) compatibility with precision agriculture, 2) reduced risk of contaminating grain due to use of fungicide coated seed and fertiliser associated with poor cleaning of contaminated trucks and augers, and 3) potential health benefits to the operators through reduced risk of exposure to fungicide from dust associated with treated seed and fungicide coated fertiliser.
Other research

Yield losses to rhizoctonia are typically more serious with disc seeders, probably due to a combination of hair pinning inoculum into the seeding zone, reduced soil disturbance below the seed and possibly reduced disruption of the hyphal network. Some growers increasingly want to switch to disc seeders because they cope better with stony soils and enable greater crop residue retention and faster sowing speeds.

With the significant improvement in control of rhizoctonia being achieved with Uniform®, further work is recommended to:

- Evaluate banding options with different disc seeding systems; e.g. single, double and triple disc seeders.
- Investigate whether or not moving surface rhizoctonia inoculum away from the disc can reduce hair-pinning inoculum into the seed zone.

Fungicide efficacy when using low water volume applications (30-40L/ha) should also be confirmed with a view to reducing the water volumes required for the split banding technique to be successful.

Intellectual property summary

Syngenta will seek registration of Uniform® to control rhizoctonia root rot in wheat and barley and own the IP directly reliant on their product.

Addendum

Since this report was written, Uniform® has gained registration (December 2014).

Additional information
