

10.0 CONCLUSIONS

10.1 Fungicide dose-response curves

10.1.1 Powdery mildew

- None of the products tested provided very good control when applied as a single spray programme at or near to flag leaf emergence, underlining the need for early treatment, usually as part of a two- or three-spray programme, in commercial practice.
- The severe test of the fungicides achieved the desired effect of identifying differences between active ingredients.
- The newer triazole fungicides provided levels of control comparable to those achieved by the morpholines.
- Unix, Neon and the strobilurin/morpholine mixture Ensign, gave good control. The relatively poor performance of Fortress may reflect the predominance of eradicant data in the set. Data from associated projects suggest that the protectant effect of this active ingredient can be good and long lasting, when applied early in the expansion of the upper canopy.
- Yield responses to treatment related more to the control of low levels of non-target diseases, than to the control of moderate severity powdery mildew. This supports the view that the impact of a unit severity of mildew on yield is less than that of the rusts and septorias.

10.1.2 *S. nodorum*

- Leaf spot and glume blotch caused by *Stagonospora nodorum* was confirmed as an important disease of winter wheat which substantially reduced yield under the favourable conditions experienced in south west England.
- On the susceptible variety Admiral, the combined loss of green leaf and ear area, toxin action and interruption of carbohydrate transfer to the grain, reduced untreated yield was reduced to less than 1 t/ha.
- *S. nodorum* and *S. nodorum* usually occurred together on leaves and it was rarely possible to separate out the effects of the individual diseases. In most cases, yield effects reflected control of both diseases.
- Most fungicide applications required both eradicant and protective activity to control *S. nodorum* effectively. The conazole fungicides Opus and Caramba gave most effective control on leaves, but required three-quarter or full dose to achieve good control. Other conazoles, gave less effective control.

- Strobilurin fungicides (Amistar and Ensign) which lacked eradicant activity, were poor on leaf disease, but quarter doses gave reasonable control of glume blotch where eradicant activity was not required. The Opus/strobilurin mixture (Landmark) behaved very much like Opus.
- Unix showed good activity against *S. nodorum* on both leaves and ears, even at a quarter dose, but had very little effect on *S. tritici*.
- *S. nodorum* (combined with *S. tritici*) caused substantial yield loss and the susceptible variety Brigadier never achieved full yield potential, even when two fungicide treatments were used. Landmark, Opus, Folicur and Caramba gave the greatest yield responses, but usually required a full dose.

10.1.3 Brown rust

- The relative performance of products did not differ significantly between eradicant and protectant circumstances.
- The most effective control was provided by triazole and triazole based mixtures.
- Amistar, Ensign and Neon provided useful control
- Additional yield benefits were obtained from strobilurins, when used in mixture with an effective triazole.

10.1.4 Improving dose-response parameter estimation

- An exponential distribution of dose points (0, 0.25, 0.5, 1.0 and 2.0) provided a modest, but worthwhile, improvement in the precision with which product performance was quantified.
- Presentations of response curves which include doses greater than those recommended, need to be prefixed by a warning that application of such doses would be illegal in commercial practice.
- A statistical methodology to allow data collected from experiments using an exponential distribution to be related to the existing data set, gathered using a linear distribution of doses, remains to be developed.

10.1.5 Relating responses between experiments

- To be of enduring value to the industry, information on the performance of products needs to be kept current. In particular, novel fungicides will continue to enter the market and their performance relative to products in the existing data set will need to be assessed.

- It would be inefficient to re-run multi-site experiments with the entire range of existing fungicide active ingredients, each time a new fungicide nears approval, in order to allow a direct comparison.
- A statistical method has been developed and tested, to allow new fungicides to be assessed in relation to a small number of 'standards', which can then be used to relate the performance of that product to others in the existing data set.
- This method has been used to inter-relate *Septoria tritici* data across all the products tested during the five years of the Appropriate Fungicide Doses project.

10.2 Dose-response by variety interactions

10.2.1 Powdery mildew

- Varieties differed in their partial resistance to powdery mildew and this was reflected in the untreated severity values.
- The dose-response curvature parameter k was common across varieties and the lower asymptotes were all small and fell within a narrow range of values. Hence, proportional control with any given dose was found to be similar across varieties, making resistance and dose directly 'tradeable'.
- Green leaf area, yield and grain quality were affected more by non-target diseases than by powdery mildew.

10.2.2 *S. nodorum*

- Varieties differed considerably in their susceptibility to *S. nodorum*. Admiral and Brigadier were severely affected and Spark showed good resistance.
- Quarter dose fungicide gave good control of *S. nodorum* on Admiral, but on Brigadier, three-quarter or full dose was required.
- Varieties generally behaved similarly in terms of yield response to increasing fungicide dose. Increasing the dose of Folicur from three-quarters to full gave only a small increase in yield, but none of the varieties achieved their full yield potential

10.2.3 Brown rust

- A statistically significant interaction was detected between the eradicator/protectant category of the assessment data and variety, suggesting that eradicator and protectant disease and green leaf area data should be interpreted separately. In practical terms however, the differences between the two data sets were of minor importance.

- The impact of major gene and partial resistance on the severity of untreated disease was substantial. Varying between 45% infection on Buster to zero disease on Abbot.
- In some cases, disease was reduced to such a low level by host resistance that it was impossible to fit dose-response curves.
- The fitted curves showed common k values and a parameters that fell within a narrow range of low values, so proportional disease control was similar, even across varieties with widely differing untreated severities.
- Disease severities on the more resistant varieties in the absence of treatment were lower than those on the most susceptible variety treated with a full dose of triazole + morpholine mixture.

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