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## The onset and effectiveness of Adult Plant Resistance (APR) in Tallon barley

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# Abstract

Field observations of net blotch epidemics indicated that Tallon barley was quite resistant to infection during later stages of growth despite being susceptible as a seedling. A glasshouse experiment was conducted to determine the effectiveness of this resistance and when it became operative.

Three cultivars - Gilbert (very susceptible), Patty (resistant) and Tallon - were inoculated at various stages of growth with conidia of *Pyrenophora teres* f. *teres* and the infection response and leaf area diseased, recorded 13 days later. The response of Tallon clearly changed from susceptible to moderately susceptible at growth stage 33. Plants sown two weeks earlier were susceptible and plants sown two weeks later were moderately resistant. The response of the other two cultivars at similar growth stages paralleled their seedling responses. The resistance of Tallon appeared to increase with maturity so that, at its most resistant growth stage, the leaf area diseased was just 10% that of the susceptible, Gilbert.

While this resistance appears pathotype specific, this experiment demonstrated very effective APR to net blotch. As most losses to this disease occur during the later stages of plant development, APR offers a valuable source of resistance.

# Introduction

APR is well documented in several host/pathogen systems (Mandeep *et al.* 2000, Jensen *et al.* 1999, Singh and Rajaram, 1994). It provides very effective protection against biotrophic fungi such as stripe rust (*Puccinia striiformis tritici*) and leaf rust (*Puccinia triticina*) in wheat. In addition, APR appears more durable than major gene resistance expressed in seedlings. Resistance conferred by genes for APR to *P. striiformis* also appears cumulative so that combinations of several APR genes offer very effective control of stripe rust (Bariana and McIntosh 1995). Inconsistencies

between seedling and adult plant response for resistance to net blotch has been observed for some genotypes by the author and demonstrated by Tekauz (1986).

Under heavy natural epidemics of net blotch in Queensland in 1998, the malting variety, Tallon repeatedly outyielded the feed variety Gilbert in Stage 4 trials, despite the latter variety having an 8 to 10% potential yield advantage. Seedling screening of both varieties showed no differences in susceptibility to the predominant pathotype in the area; yet field observations of plots at heading indicated substantially less disease on Tallon.

Two field trials conducted in 1999, using infected stubble from a commercial crop as inoculum, provided an opportunity to compare the effects of moderate epidemics on both varieties. Tallon had significantly less disease and suffered significantly less yield depression than Gilbert. The surprisingly low level of disease on Tallon and its response to infection in this trial indicated that the variety was resistant to the pathotype present; however subsequent seedling testing revealed that both varieties were very susceptible to the same isolate. It was concluded that Tallon may possess classical APR to net blotch.

A glasshouse trial was conducted to confirm the presence of APR in Tallon; to determine when this resistance became effective and to evaluate the effectiveness of this resistance.

## Materials and Methods

**Glasshouse** The varieties Gilbert (very susceptible), Patty (resistant) and Tallon were sown into 15cm pots in the glasshouse at fortnightly intervals spanning 14 weeks. Pots of each sowing were grouped together and repositioned regularly within the group to avoid differential shading and other environmental effects. When plants of the last sowing were three weeks old, growth stages were recorded and plants inoculated in a semi-quantitative manner.

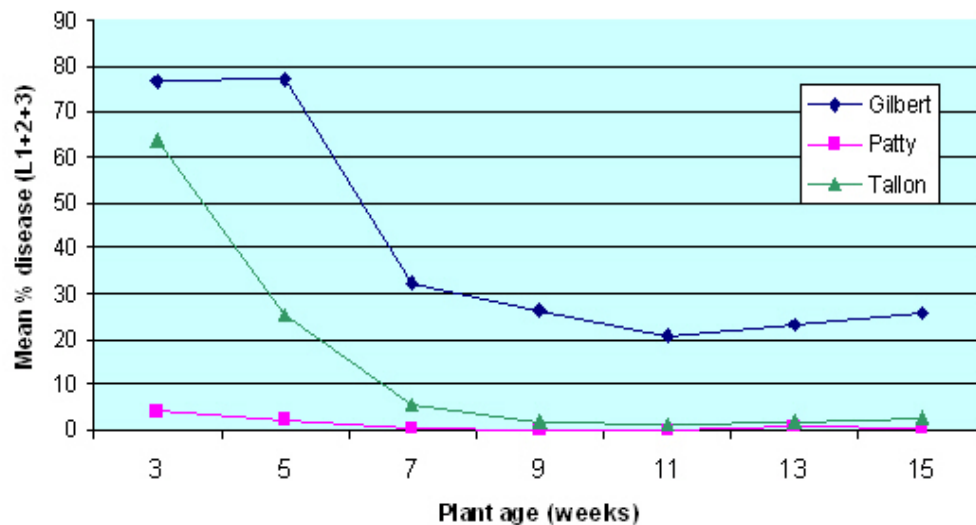
Pots of each replicate were arranged in single file on a laboratory bench and sprayed with an aqueous suspension of *P. t. f. teres*, isolate NB321, containing 15,000 conidia/mL. This isolate was taken from stubble used as inoculum in the 1999 field trials. The suspension was applied using an airless spray gun (Krebs® Model 25T). Plants were inoculated from two sides, then pots rotated 90° and repeat inoculated. After each replicate was inoculated, plants were transferred to a fogging chamber and maintained at 19°C for 14hours under continuous dark followed by 10hours light.

Plants were returned to the glasshouse and maintained in a row/column design with adequate spacing to minimise shading from neighbouring plants until notes were taken 13days later. Leaf area diseased and infection response were recorded for the three uppermost leaves on each primary tiller. Infection response was assessed on the following scale:- 1 = resistant (R); 3 = moderately resistant (MR); 5 = moderately susceptible (MS); 7 = susceptible (S) and 9 = very susceptible (VS). Glasshouse temperatures during disease development ranged between 15 and 27°C.

**Field** Two trials were conducted. Trial 1 contained ten treatments of the varieties Gilbert and Tallon in a randomised complete block design. In Trial 2, Gilbert and Tallon were two of eight lines being evaluated for resistance to net blotch in a row/column design. In both trials, infected stubble was applied to plots shortly after emergence at 2t/Ha and the net blotch epidemic promoted using sprinkler irrigation. Propiconazole was applied to "disease free" treatments of each variety at fortnightly intervals at 125mL/Ha. Disease levels were assessed in Trials 1 and 2 when Tallon was at Zadoks growth stages 83 and 73 respectively.

## Results and Discussion

**Glasshouse** The resistance of all varieties increased with plant age; however this was most pronounced in Tallon (Fig.1). There was a definite transition over a one month period - between 5 and 9 weeks from sowing - from a near VS response of 8.7 to 2.6 which is less than MR. Tallon plants at 7weeks had an infection response of 4.7(< MS) and indicated that APR had not become fully effective at that growth stage.



**Figure 1. Effect of plant age on disease level**

It would appear that APR in Tallon, under the conditions of this experiment, became effective after formation of the second node (Zadoks growth stage 33) and increased in effectiveness for several weeks thereafter. The average levels of resistance in Tallon did not reach the levels of Patty but all sowings of Tallon, nine weeks or older, gave an infection response between MR and R.

Although Patty and Gilbert had less disease as adults than during the vegetative period, the change in infection response with age was much less than in Tallon. The average infection response in Patty dropped from 3.8 to 1.0 while Gilbert changed from 9 to 7.2. Therefore both these varieties retained their relative susceptibilities at all growth stages but Tallon changed from being similar to Gilbert as a seedling to close to the resistance of Patty as an adult.

Comparison of disease levels also indicated that the transition from seedling to adult plant resistance commenced earlier in Tallon than in Gilbert. Diseased leaf area of Tallon dropped sharply from 64% when plants were three weeks old to 25% when five weeks old. The levels of disease in Gilbert remained virtually the same at three and five weeks and decreased sharply by seven weeks. This may suggest that genotypes with useful levels of APR not only develop less disease but show an adult response earlier than lines without effective APR.

The pronounced decline in leaf area diseased between seedling and adult plant appears to be due to the differences in toxin activity of the fungus. In seedlings much of the diseased tissue is a result of rapid spread of the toxin while in adults this seems to play much less a role and leaf area affected depends more on lesion size and expansion.

**Field** In Trial 1, net blotch infection in Tallon resulted in a 9.7% reduction in yield (Table 1) while the same epidemic caused a 29.3% reduction in the yield of Gilbert over the sprayed control. Even though propiconazole was applied fortnightly there was still a low level of net blotch (14%) in sprayed treatments and consequently this figure is likely to be an underestimate of the true effects of the disease in Gilbert. The differences in yield response corresponded to a ten fold difference in the amount of disease on the flag + flag-1 leaves between the unsprayed plots of Tallon and Gilbert.

**Table 1. Effects of net blotch on yields of Tallon and Gilbert barleys**

Treatment	Trial 1				Trial 2			
	% disease (L1+L2) log transf	Equiv means	Yield gm <sup>-2</sup>	Yield loss %	% disease (L1+L2+L3) log transf	Equiv means	Yield gm <sup>-2</sup>	Yield loss %
Tallon sprayed	0.208	1.23	564	-	-	-	462	-
Tallon diseased	1.549	4.71	506	9.7	1.37	4.3	424	7.5
Gilbert sprayed	2.636	14.0	572	-	-	-	451	-
Gilbert	3.713	41	404	29.3	3.71	42.5	341	24.3

diseased							
LSD <0.05	0.602		86.2		1.004		32.6

In Trial 2 the same trends were observed. Because plots were assessed at an earlier growth stage disease levels on the top 3 leaves were able to be recorded. Again there was a ten fold difference between the leaf area diseased on the unsprayed Tallon and Gilbert which resulted in yield reductions of 7.5% and 24.3% respectively over the sprayed controls.

## Conclusion

The presence of APR in Tallon barley proved effective in reducing disease levels and yield loss. Under the conditions of this experiment, APR became effective at around growth stage 33 and provided only slightly inferior protection against net blotch than the resistant variety Patty. This level of resistance was adequate to protect the variety against significant yield loss under a moderate epidemic of the disease.

It would appear that this resistance may be pathotype specific and further experiments are underway to clarify this. It is also possible that different adult plant resistances to net blotch may exist in other genotypes. If these can be identified and combined, high levels of resistance, with the prospect of greater durability than that afforded by specific major genes, may be achieved.

## Acknowledgments

The author wishes to acknowledge the financial support provided by GRDC and the technical assistance given by Stuart Meldrum and Janet Barsby. My thanks to Ms Kerry Bell for analysis of the data.

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