SEED TREATMENT ACCORDING TO NEED IN SCOTLAND: BARLEY NET BLOTCH

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Summary: In an experiment examining the relationship between seed-borne net blotch infection levels (nil – 40%), the presence or absence of infected stubble and the application of seed treatment it was found that disease symptoms at growth stages (GS) 20/21 and 31 are directly correlated to levels of seed infection. Seed treatment effectively controls the disease at GS 20/21 and GS31, where seed-borne infection is the only source of inoculum. At GS 31, where infected stubble was present, the application of seed treatment showed no benefit when applied to seed with infection levels of 15% or less. Flag leaf infection at growth stage 83 is unrelated to seed-borne infection and is due to a combination of different factors which makes it difficult to deduce the significance of seed-borne inoculum in comparison to stubble inoculum. Where it is possible to develop strategies of treatment according to need for barley leaf stripe and loose smut, there is a need for further work in defining meaningful seed infection thresholds for net blotch. There is also a need to educate seed producers and growers regarding the management of seed-borne disease in the production of healthy seed crops.

INTRODUCTION

The UK approach to the maintenance of cereal seed health and the use of seed treatment was reviewed by Paveley *et al* (1996). They identified options for changing to a strategy of "treatment according to need" to improve both seed health and the economic efficiency of seed production in the long term rather than blanket seed treatment which ignores the health status of the seed being treated. They suggested that a limited treatment according to need approach to the use of fungicide seed treatment for spring barley might be particularly relevant to Scotland where spring barley occupies 60% of the Scottish cereal area. The feasibility of such a practice was based on the use of the currently available seed testing techniques and current advisory thresholds for the two major seed-borne diseases of barley: loose smut (*Ustilago nuda*) and leaf stripe (*Pyrenophora graminea*). Growers using such a strategy would benefit from savings in seed treatment cost.

A maximum infection threshold of 2% was adopted for leaf stripe in 1992 as part of the Voluntary Code of Practice for Barley Leaf Stripe, introduced after leaf stripe accounted for losses of up to £1.5 million in 1990 (Cockerell *et al*. 1995). Seed lots with more than 2% are treated with an effective fungicide or discarded. The advisory threshold for loose smut on the other hand, is based on the maximum permitted level of infection, allowed in seed certified to the UK minimum standard, 0.5%, (Anon.1993). Ergot (*Claviceps purpurea*) also has standards within the current UK Cereals Seeds Regulations (Anon. 1995) with no more than 3 pieces allowed in 500g of seed certified to the UK minimum standard.

As well as leaf stripe, seed-borne diseases such as brown foot rot (*Cochliobolus sativus)* and net blotch (*Pyrenophora teres*) have no standard within the UK seeds regulations. Seed-borne brown foot rot can affect the establishment of spring barley crops when untreated seed of susceptible varieties are sown (Whittle & Richardson 1978), and seed-borne net blotch can introduce the disease to an area that has no previous history of net blotch. In England and Wales, however, the same advisory limit used to control barley leaf stripe is suggested for net blotch. This could be seen as extremely cautious, as other sources of inoculum such as infected straw/stubble or volunteers are considered more important in the build up of the disease within the crop (Jordan 1981).

During 1997, producers of certified spring barley seed in Scotland, were concerned that seed-borne *P. teres* was resulting in high levels of net blotch in the growing crop, despite being grown from fungicide treated seed. Spring barley samples received for testing by the Official Seed Testing Station (OSTS) for Scotland showed *P. teres* seed infection levels of up to 64%. Particular problems were associated with the cv. Prisma: 25% of Prisma samples tested in 1997 and 17% of samples tested in 1999 had over 20% infection. A number of questions were raised: What is the significance of seed-borne net blotch?; At what level of infection is it necessary to apply a seed treatment?; How effective are seed treatments?

This paper describes an experiment carried out at SASA to determine the relationship between different levels of *P. teres* seed infection and disease expression at two fields sites one with and one without an additional *P. teres* inoculum source.

MATERIALS AND METHODS

Seed samples with a range of *P. teres* infection levels (0, 5, 10, 15, 20, 25, 30, 35 and 40%) were prepared by mixing different proportions of an infected seed lot (cv. Prisma, 40% infection) and a non-infected seed lot (cv. Prisma, nil infection). Each of the 9 samples was thoroughly mixed by passing the seed through a Boerner divider 3 times (Anon. 1999). Using the divider each sample was then divided into sub-samples. Two sub-samples were treated with Raxil S (20g/l tebuconazole and 20g/l triazoxide) at 150ml per 100kg seed using an ICI Rotostat and two sub-samples were left untreated.

Three x 10 m^2 plots from each sub-sample were sown at two sites, Gogarbank Farm and East Craigs, Edinburgh, using a sowing rate of 350 seeds/m^2. At Gogarbank plots were sown next to an area where *P. teres* infected stubble was present throughout the experiment. No infected stubble was present at the East Craigs site.

The percentage of diseased seedlings (GS 20/21) and diseased tillers (GS 31) in 5 x 1m rows per plot were recorded. The percentage of tillers with infected flag leaves (GS 83) was also recorded.

RESULTS

Seedling assessments

There was a significant difference between untreated and treated seed at both sites ($p<0.001$). At both sites no infection was recorded in treated plots or plots sown with seed of nil infection. There was no overall difference in the number of infected seedlings recorded at each site and there was a significant relationship for untreated seed between seed infection and seedlings showing symptoms (Figure 1a).

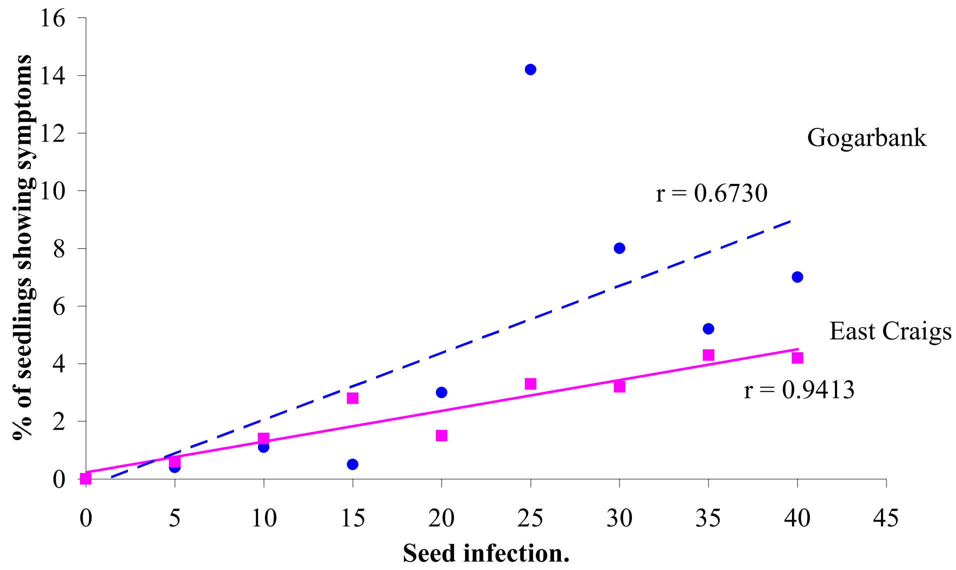
Tiller assessments

Again, at GS 31 there was a significant difference between untreated and treated seed at both sites ($p<0.001$). The treated seed at both sites had lower levels of disease than the untreated seed. As in seedling assessments there was a significant relationship between seed infection and the percentage of infected tillers showing net blotch symptoms (Figure 1b) for untreated seed. There was no relationship between treated seed and seed infection levels at either site. There was a statistical difference between treated means ($p>0.001$), with higher infection levels recorded at Gogarbank where infected stubble was present.

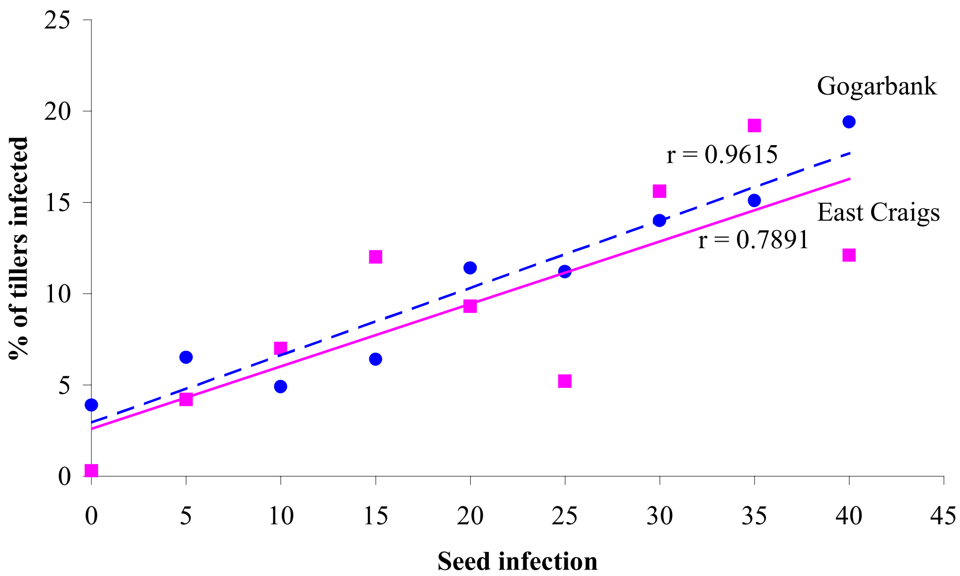
Figure 1

The relationship between original seed infection and the percentage of (a) infected seedlings at GS 20/21 and (b) infected tillers at GS31, in untreated plots.

(a)



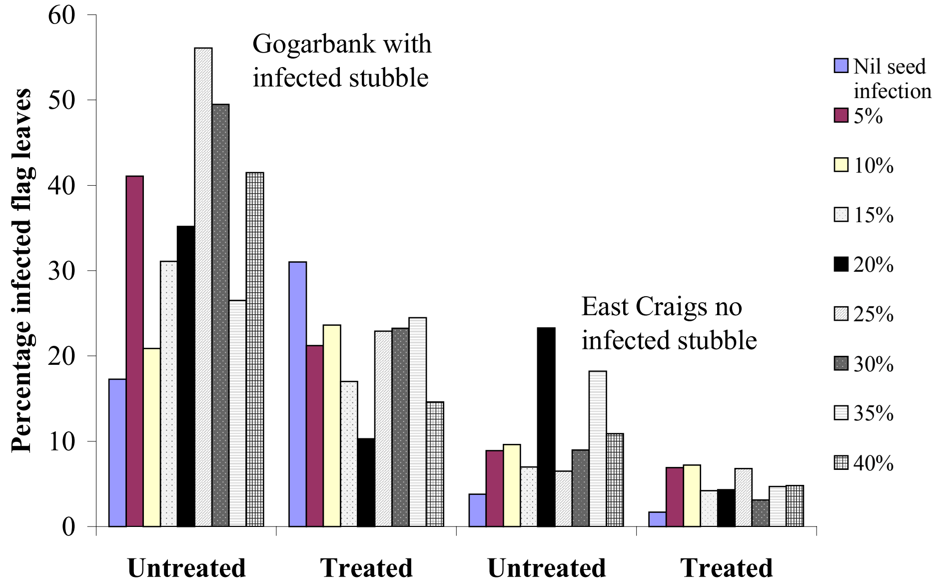
(b)



Flag leaf assessments

At GS 83 there was a significant difference between the percentage of infected flag leaves at each site (Figure 2). Disease levels were higher at the site with infected stubble. The percentage of diseased flag leaves was higher in the untreated plots compared to the treated plots at both sites ($P<0.05$). Unlike seedling and tiller infections there is no relationship between seed infection and percentage of flag leaves with net blotch symptoms.

Figure 2
The percentage of infected flag leaves recorded at GS 83 at both sites.



DISCUSSION

The use of untreated barley seed has increased by 80% in Scotland from 8614 ha in 1996 to 15590 ha in 2000 (Snowden & McCreath 1997, Kerr & Snowden 2001). During this period there has been no increase in the levels of the two major seed-borne diseases, barley loose smut and leaf stripe (V. Cockerell personal communication). Indeed, no leaf stripe has been recorded in Scottish barley seed tested at the OSTS since 1997, with the exception of a sample of bere barley (an old land race) from Orkney where 34% infection was recorded. However in some years, there have been increased levels of seed-borne net blotch, but this increase was not associated with the use of untreated seed as many of the affected crops had been grown from treated seed.

The value of seed health testing lies in its ability to support decisions about suitability for seed, the need for treatment and the type of treatment required. Clearly, there is a significant relationship between seed-borne infection of net blotch and percentage of plants infected up to growth stage 31 when seeds are sown untreated, with average seed-borne transmission ranging from 10% to 20% (Figure 1). At GS 31, this study shows that in 2001 the application of Raxil S, at the Gogarbank site, had no benefit in suppressing the disease, when applied to seed with infection levels of 15% or less. At the East Craigs site on the other hand, seed treatment provided effective control at all levels of seed infection. The expression of symptoms at GS 83 was unrelated to the level of seed-borne infection.

Where seed-borne infection is the main inoculum source, seed treatment significantly reduced the build up of the disease in the crop. At the Gogarbank site, where there was an additional inoculum source, seed treatment also reduced the build up of the disease compared to the untreated plots. In this case the reduction is unlikely to be economically significant as a fungicide treatment in the field may still have been necessary as infection was apparent at growth stage 31 and average flag leaf infection levels were 20% (Figure 2).

Seed infection levels were not related to levels of flag leaf symptoms and at the East Craigs site it is probable that the infection in plots grown from treated seed was due to inoculum from untreated infected plots. At the Gogarbank site the infection in the treated plots would be due to a combination of inoculum from two sources; the infected stubble, and the untreated infected plots. It is therefore difficult to decipher the true significance of seed-borne infection in comparison to stubble inoculum in the build up of disease within a crop. The availability of molecular techniques, which can measure the presence of seed-borne *P. teres* populations against existing straw/stubble populations, may provide the answer (Cockerell 2001).

The use of targeted fungicide sprays can effectively control net blotch in the growing crop. This is not the case however for leaf stripe or loose smut where both diseases have the ability to multiply significantly between years. In 1990, a commercial spring barley crop with 1% of plants infected with leaf stripe resulted in 54% of the harvested grain infected (Cockerell *et al.* 1995). Similarly, work done at SASA has shown that a seed lot of winter barley sown with 0.2% loose smut infection resulted in harvested seed with 4% infection (V. Cockerell personal communication). Both diseases are spread when wind-borne spores from infected plants are blown onto healthy plants. In both cases spores have been shown to spread up to 200m from an infected source (V. Cockerell Personal communication). It is therefore important to monitor levels of disease during multiplication and apply an effective fungicide where necessary to ensure that seed being used to produce a grain crop meet the required thresholds.

Survey evidence (Cockerell & Rennie 1996) suggests that in most seasons it may be possible to sow up to 80% of barley being grown for grain, untreated, giving savings of approximately £1.7 million per annum. This would depend on the level at which treatment thresholds are set and the improved management of seed-borne disease during multiplication.

Since the review by Paveley *et al* (1996), the need for growers to reduce costs has increased. A competitive world cereal market has continued to demand lower production costs. The range of seed treatments, aimed at controlling different combinations of seed-borne pathogens as well as other crop pests and diseases, provides a diversity of products, that encourages growers to target seed treatments to the range of pathogens present. Increased consumer concerns for the environment and food safety, and the introduction of more rigorous quality standards imposed by end use markets all require that pesticide use should be according to need.

However, before treatment according to need can be fully adopted there is still a need for further research in defining meaningful net blotch thresholds and the need to educate seed producers and growers in understanding the management of seed-borne disease in the production of a healthy seed crop.

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