HGCA

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APPROPRIATE FUNGICIDE DOSES FOR WINTER BARLEY VOLUME I: EVALUATION OF APPROPRIATE FUNGICIDE DOSE PROGRAMMES

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APPROPRIATE FUNGICIDE DOSES FOR WINTER BARLEY

VOLUME I: EVALUATION OF APPROPRIATE FUNGICIDE DOSE PROGRAMMES

By

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NB. Volume I contains the report of Experiment 3 carried out under project no. 1398. Experiments 1 and 2 are reported within Part 3 of Volume II.

HGCA WINTER BARLEY APPROPRIATE FUNGICIDE DOSE PROJECT
VOLUME I: EVALUATION OF APPROPRIATE FUNGICIDE DOSE PROGRAMMES

PROJECT Reference 1398 (part)

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EXPERIMENT 3.
EVALUATION OF APPROPRIATE FUNGICIDE DOSE PROGRAMMES

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1. INTRODUCTION

The use of reduced fungicide doses has become accepted practice in the UK. Growers have found with increasing confidence that full doses are rarely required in order to achieve acceptable disease control. Pressure on gross margins of winter barley since the mid-1980's have been the stimulus to use reduced doses. Many growers, consultants and advisers have developed, through experience, the ability to judge by how much a dose can be reduced in a particular situation. They are integrating factors, often unconsciously, that influence disease development with a knowledge of fungicides to arrive at an appropriate dose. However, disease surveys of winter barley have suggested that many fungicide programmes are still inappropriate. In addition, there have been few studies into how the most appropriate fungicide dose is determined. It is with this background that Experiment 3 of the winter barley appropriate fungicide dose project has been carried out. The intention of this experiment, in combination with experiments 1 and 2 was to provide a more scientific basis to determining appropriate fungicide doses.

The most appropriate fungicide dose for any situation is that which prevents disease development and retains yield to the extent that optimum profit (value of extra yield less cost of fungicide application) is achieved. One element of deciding on the dose is to predict by how much disease would develop if no fungicide was applied. The extent of development depends largely on three factors, the amount of disease present, the immediate past and predicted future weather and the disease resistance ratings of the host. However, yield loss resulting from disease development will vary at different stages of crop growth. At some stages, disease development has little effect on yield and fungicide application would be unnecessary. Conversely, where the yield penalty for disease development is high then the fungicide dose should reflect effective control of disease. Thus the risk of disease-induced yield loss has to be incorporated into the decision making process. Paveley (1993) developed a concept called Integrated Disease Risk (IDR) Strategy to integrate all the key factors affecting disease-induced yield loss for winter wheat. Part of this experiment was to set up a similar strategy for winter barley and evaluate it.

It has been well established that two key timings for winter barley are at early stem extension (GS 31/2) and the flag leaf stage (GS 39-49). There is other evidence (e.g. Wale, 1987), that earlier (GS 30) applications can also be cost effective. Thus this experiment set out to examine every combination of five fungicide doses (0, 0.25, 0.5, 0.75 and full) at each of three timings. In total this is 125 possible combinations (5 x 5 x 5) and with replication this would have resulted in a very large unmanageable trial. In other disciplines, one mathematical technique that has been used where only a limited number of the total combinations can be examined is surface response analysis. By this technique, interpolation from the data points tested to those untested is possible. It was considered, therefore, that by testing 39 of the 125

possible combinations sufficient data would be generated to produce sound response surfaces to identify optimum programmes. Disease assessment of the 39 programmes tested on a leaf layer basis provided the information by which to interpret the surface responses. Using the basic 39 fungicide programmes, other ways of examining the cost effectiveness of programmes is possible. In this report both surface response analysis and a more empirical form of analysis of the results are presented.

To test out a prototype IDR Strategy for winter barley, a 40th programme was evaluated where the dose at each timing was determined from the prototype IDR protocol by the local site manager.

2. OBJECTIVES

The main objectives were:

a. To test appropriate dose spray programmes in a range of disease risk conditions and thereby to determine the minimum fungicide inputs that achieve optimum profitability.

b. To determine the effect of fungicide timing and dose on disease progress and to relate this to yield and grain quality.

c. To develop an Integrated Disease Risk (IDR) strategy for winter barley.

3. MATERIALS AND METHODS

3.1. Locations of trials

In each of three years (1993/4, 1994/5 and 1995/6), the experiment was carried out at three sites:

S1	SAC-Aberdeen, Tillycorthie Farm, Udny, Aberdeenshire, AB41 4SD
S2	Morley Research Centre, Morley, Wymondham, Norfolk, NR18 9DB
S3	ADAS Rosemaund, Preston Wynne, Hereford, HR1 3PG

3.2. Variety

At all sites and in each season, the variety Pastoral was used in the experiment. This variety was chosen because it was a widely grown and popular variety in the UK and was relatively responsive to fungicide treatment. Using the same variety at each site ensured cross-site uniformity and comparability.

3.3. Fungicide

The fungicide used was a tank mixture of Tilt 250 EC (propiconazole 250 g/litre, Novartis) and Aura 750 EC (fenpropimorph 750 g/litre, Novartis). This fungicide mixture was also used in experiments 1 and 2.

The doses of product used were:

Dose	Tilt	+	Aura
0.25	0.125	+	0.188
0.5	0.25	+	0.375
0.75	0.375	+	0.563
1.0 (full)	0.5	+	0.75

3.4. Fungicide programmes

The 39 programmes tested were determined in collaboration with Dr Mike Franklin, Biomathamatics and Statistics Scotland (BioSS).

The programmes examined three **timings:**

GS 30	(3-4 weeks prior to GS 31/2)
GS 31/2	
GS 39/49	(3-4 weeks after GS 31/2)

and five **fungicide doses.**

The thirty-nine programmes (timings x dose combinations) were selected in two stages.

a) About 25 programmes were selected to ensure an even distribution across the matrix of all possible combinations.
b) Further programmes were selected, firstly to ensure a wide range of total doses (i.e. the accumulated dose from applications at all three timings) and secondly to test combinations of timing and dose relevant to earlier studies.

The matrix of timing x dose combinations changed slightly after the first year to improve the range of total fungicide doses and particularly to increase the replication of the untreated control to four. A reliable estimate of the untreated control was required as the anchor point to determine yield response. The matrix of timing x dose combinations tested in each year is shown over page.

A further treatment (40) tested the protocol IDR strategy. The IDR programme is described in detail in Appendix 6. At Morley in 1995 an extra treatment (41) was included where the IDR programme (40) was applied but using Sanction (flusilazole 400 g/l) instead of Tilt in the fungicide mixture.

Each of the 39 treatments had two replicates, whilst the IDR programme was replicated three times.

Dose at		GS 30 0 dose	GS 30 ¼ dose	GS 30 ½ dose	GS 30 ¾ dose	GS 30 1 dose
GS	GS 39					
31 ↓	↘	0 ¼ ½ ¾ 1	0 ¼ ½ ¾ 1	0 ¼ ½ ¾ 1	0 ¼ ½ ¾ 1	0 ¼ ½ ¾ 1
0		X X X X X	X X X	X X X	X X	X
¼		X X X	A X	A	X	X
½		X X M	X B	X X	X	B A
¾		X X M M	X B	B X	A	A
1		X M X	X	X	X	X

X represents 'core' programmes, applied in each of the three years
A represents programmes applied only in the first year
B represents programmes applied only in the second and third years
M represents additional treatment combinations examined at Morley Research Station in the third year

3.5. Layout

A detailed layout for each trial was provided by Dr Mike Franklin, Biomathamatics and Statistics Scotland (BioSS). Each trial comprised three banks of 27 plots, divided into two halves. Each half contained one randomly assigned replicate of the 39 programmes and the IDR programme. The middle plot was the third replicate of the IDR programme.

3.6. Disease assessment

Foliar disease was assessed on up to 14 occasions at 10-11 day intervals from February to GS 75. All green leaves on ten tillers were examined from each plot and results expressed as percent leaf area infected. On each occasion leaves were tagged on 10-15 indicator plants to allow disease progress curves for individual leaf layers to be calculated for each disease.

Stem base diseases were monitored in untreated plots at GS 31/2 and GS 75. In no case did disease reach the threshold (of >20% tillers with moderate-severe lesions at GS 75) to make a full assessment of all plots necessary. None of the trials suffered lodging.

3.7. Yield and grain quality assessments

Plots were yielded and a sample of grain taken for determination of dry matter content, specific weight and thousand grain weight. Yields were adjusted to t/ha at 15% moisture.

3.8. Meteorological data

At each site, meteorological data; temperature, humidity, rainfall and leaf wetness, were recorded from mid-February to senescence.

3.9. Pattern of disease development

Brief descriptions of the patterns of disease development are given in Table 3.1.

Table 3.1. Listing of trial sites, their assigned codes and brief description of the pattern of disease development.

Year	Organisation	Site	Site code	Pattern of disease development on untreated plots
1994	SAC-Aberdeen	Tillycorthie	B3Y1S1	Rhynchosporium was at low levels at GS30. It developed to modest levels on the 4th top leaf but remained at low levels on other leaves. Mildew was present at trace levels
	Morley Research Centre	Morley	B3Y1S2	Net blotch and Rhynchosporium were found on upper leaves at GS30 and these diseases remained at trace to low levels throughout. Only traces of brown rust and mildew were present.
	ADAS Rosemaund	Rosemaund	B3Y1S3	Mildew and Rhynchosporium were present throughout with mildew developing to moderate levels on the top four leaves. Rhynchosporium remained at low levels. Net blotch and brown rust were at trace levels.
1995	Aberdeen	Tillycorthie	B3Y2S1	Mildew was the principal disease at the time of spraying, with traces of brown rust and Rhynchosporium also present. Mildew progressed to a severe epidemic. Rhynchosporium persisted at low levels and brown rust reached low levels on the top two leaves.

	Morley Research Centre	Morley	B3Y2S2	Traces of all four foliar diseases were present in spring. Brown rust developed to severe levels on the top three leaves
	ADAS Rosemaund	Rosemaund	B3Y2S3	Rhynchosporium, brown rust and mildew were present at trace levels at GS 30. Brown rust developed to low levels on the top four leaves but mildew and Rhynchosporium remained at very low levels. Take all caused premature ripening and may have depressed yields.

1996	Aberdeen	Tillycorthie	B3Y3S1	Mildew and Rhynchosporium were established on the uppermost fully expanded leaves at GS 30. Mildew progressed to severe levels on the top three leaves whilst Rhynchosporium continued at low to moderate levels.
	Morley Research Centre	Morley	B3Y3S2	Very low levels of disease were present throughout with only net blotch reaching 1-2% infection on leaves 2 to 4.
	ADAS Rosemaund	Rosemaund	B3Y3S3	Low levels of mildew and Rhynchosporium with traces of net blotch were present at GS 30. Mildew and Rhynchosporium progressed to low-moderate levels on leaves 2 to 4.

3.10. Analysis of data

3.10.1. Use of additive models to adjust yield for variations in soil fertility and surface response analysis for yield and profitability.

In agricultural field experiments it is required to compare the performance of different treatments under near identical conditions. However, sites are naturally variable so that some treatments may be positioned more advantageously than others. To correct for this, sites are usually divided up into blocks of plots, chosen to be as homogeneous as possible, so that treatments in the same block may be viewed as having the same conditions. With few treatments each block is made to contain each treatment exactly once, a design known as a randomised block design. With many treatments, however, the blocks are too small to contain all treatments so the resulting design is a randomised incomplete block design. In this circumstance the problem arises as to how best to compare two treatments that don't always occur together in the same block. The standard analysis of yields, say, for these trials assumes that each block is homogeneous but sudden jumps in fertility may occur between adjacent blocks. The analysis determines the effect on yield of each block and adjusts the yield of any treatment according to the blocks in which it occurred. Other techniques for adjusting for heterogeneity across a site include (1) using check plots to estimate the underlying field fertility or (2) adjusting each plot by the 'excess' yield of neighbouring plots or (3) modelling fertility across the site.

Among the approaches under (3), additive models (Hastie & Tibshirani, 1990) provide a data-driven method for modelling data. A fitted curve representing the underlying fertility is allowed to take a shape solely determined by the observations, subject to a constraint to ensure smoothness. The curve is not restricted to a parametric form (e.g. polynomial) and the method is essentially the mathematical equivalent of using 'French curves'. Additive models provide an extension to the standard multiple regression models. They "*let the data show us the appropriate functional form*" by fitting a general smooth function as opposed to a parametric function which may be inappropriate.

The smoothing function can take many forms for example running means, running lines, kernel smoothers and splines. Two forms of *smoothers* were used in these analyses, locally-weighted running line smoothers and cubic smoothing splines. Locally-weighted running line smoothers (*lowess*) estimate the *smooth*. Splines are a solution to a 'penalised least squares' problem; they fit a function which best satisfies a compromise that it fits the data and is reasonably smooth. (They minimise a term which is the sum of the lack of fit and a penalty for lack of smoothness.) Full details of the additive model are given in Harbron & Wale (1995).

In practice the additive model and the incomplete block model with suitable sized blocks are both effective ways of modelling the data. The latter is somewhat more crude but is often easier to interpret and is less liable to 'over interpretation'. In these trials neither method was seen to be clearly superior and in the final analysis the incomplete block model was adopted.

The data were analysed in two steps:

(a) production of a general model for 40 (or more) unspecified treatments to determine the effect of treatment and local fertility and to produce adjusted treatment means.

(b) an analysis of adjusted means where yields are deemed to show a smooth response to changing doses. This is an analysis of the 'response surface'.

To illustrate this in more detail we example a typical trial. The 81 plots were laid out in three banks of 27 plots. Each of the 39 response surface treatments plus the IDR treatment was assigned one of the first 40 plots and to one of the last 40 plots at random, giving two replicates per treatment. The central plot was an extra IDR treatment, this being the third replicate of this treatment. The data (yields) were analysed by a model of the form

$$Y_{ij} = p_j + t_i$$

Where p_j is the effect of the jth plot and t_i the effect of the ith treatment. The additive model and incomplete block model were used to estimate the plot and treatment effects. In the additive model the plot effects are assumed to vary in a smooth manner so smooth curves were fitted to each bank of plots. No functional form was assumed, allowing the curves to follow the data restrained only by a constraint on smoothness. The degree of constraint was determined by the degrees of freedom. More degrees of freedom allow greater flexibility (and less smoothness) in the form of the curve. In the incomplete block model it was assumed that each bank was formed by 3 uniform blocks of 9 plots i.e. the fertility trend was formed by 3 plateaux.

In the first year, 1994, the smooth trends plus treatment effects explained 62%, 54% and 53% of the variation in yield at the Aberdeen, Morley and Rosemaund sites respectively. For 1995 these figures were respectively - (incomplete block model figures in parentheses) - 73.8(72.6), 95.9(96.0), 46.5(48.0) and for 1996 they were 68.8(80.6), 76.3(79.6), 69.3(69.5). The performances of the two approaches were very similar and correlations between the two sets of adjusted yields were generally in excess of 0.9.

Because of the similarity in performance of the two methods and because incomplete block model is still the most widely used, adjusted means from this model were used for the second part of the analysis. This analysis used only the 39 adjusted treatment means from the response surface treatments.

The adjusted treatment yields predict what the yields would have been had all plots been of average fertility. In the second part of the analysis differences between these adjusted means were investigated.

The treatments were combinations of three factors - the dose applied at GS30, at GS31/2 and at GS39/49. These factors may vary in a continuous manner so that the yield responses to each may be investigated through use of smooth curves. Moreover, the way that applications at one date affect the performance of the applications at other dates may be investigated through interactions between these factors.

However, because all the factors are of essentially the same type (i.e. doses) it is possible to view the responses to treatments in a different way. Firstly, we may

determine the response to the total dose of fungicide and secondly we may determine how differences in timing affected this response. This approach is particularly relevant in the current trial when considering margins over cost because of the assumption that timing does not affect costs.

(a) When response curves show a gentle trend either straight or slightly bent then the use of quadratic curves can be very informative. This is especially so when the responses are approach a maximum as the curves can help pin-point the location of the optimum dose. In a quadratic model the response to a dose is explained by a linear or straight line component (x) and a quadratic or curved component (x^2). When the dose at one stage (x_1, say) influences the effect of the dose at another stage (x_2, say) then this can be accounted for by interaction terms of the form x_1x_2. In these trials the response trends were generally relatively gentle so we applied quadratic models of the following form:

$$\text{Yield} = a_o + a_1x_1 + a_2x_2 + a_3x_3+a_{11}x_1^2+a_{22}x_2^2+a_{33}x_3^2+a_{12}x_1x_2+a_{13}x_1x_3+a_{23}x_2x_3 \quad (1)$$

where x_1, x_2 and x_3 are the doses at GS30, GS31/2 and GS39/49 respectively, and the a values are parameters which are estimated. Such a model allows the response at each application to be curved (as one might expect from 'diminishing returns'). Also, because it is expected that in each case the dominant component would be linear, the model (1) allows for linear.linear interactions of the form x_1x_2 etc. With such interactions the response to varying the dose at say GS31 is influenced by the dose applied at GS30. (To see this, note how the terms x_1 and x_2 may be re-expressed:

$$a_1x_1 + a_2x_2 + a_{12}x_1x_2 = a_1x_1 + (a_2 + a_{12}x_1)x_2$$

The parameter for x_2 is thus affected by the value for x_1).

In modelling such surfaces there is an advantage to setting the origin or centre of interest roughly at the 'centre of gravity' of the doses. Here, with doses scaled by quarter recommended, the actual doses at each application were 0,1,2,3,4 (i.e. 1=0.25, 2=0.5 etc.) but relocating the origin at dose =2 gives levels -2, -1, 0, 1, 2. Step-wise regression was used to determine the best surface response model for each trial. Linear terms were regarded as essential components but quadratic and interaction terms that were small were omitted to form a shorter model for predicting yields. Thus for example at Rosemaund 1996 the shorter model was

$$\text{Yield} = 9.069 + 0.016x_1 + 0.128x_2 + 0.089x_3 - 0.0475x_2^2 - 0.0373x_1x_2 - 0.0496x_1x_3$$

Roughly speaking this model may be interpreted as follows. When each x equals zero (i.e. dose=2 or half recommended then the expected yield is 9.069 t/ha. Increasing x_1 by 1 that is the dose at GS30 by a quarter dose causes yield to increase by 0.016 t/ha. A same decrease in dose leads to a similar decrease in yield. The strongest yield response was to the dose at GS31/2 (x_2) at 0.128 t/ha per quarter dose. However, this response is moderated by diminishing returns as indicated by the negative contribution of x_2^2. Also, for both GS31/2 and GS39/49 the effect of increasing dose was less if a high dose was applied at GS30 than if a low dose was applied (see the negative signs on the interaction terms).

(b) In an alternative approach the treatments were re-parameterised as follows.

Total	=	GS 30 + GS 31/2 + GS 39/49
Timing1	=	GS 39/49 - GS 30
Timing2	=	GS 39/49 + GS 30 -2 x GS 31/2

Total is the total amount of fungicide applied over the three application times, this relates directly to the cost of each treatment.

Timing1 contrasts between early application of fungicide (GS 30) and late application of fungicide (GS 39/49); it increases with lateness.

Timing2 in effect measures the importance of late and early applications versus the middle application (growth stage 31/2 -commonly viewed as the most important timing). An interpretation of the three variables is summarised below.

NEGATIVE VALUES		**POSITIVE VALUES**
Little fungicide applied	TOTAL	Much fungicide applied
Early applications emphasised	TIMING1	Late applications emphasised
Emphasis on application at GS31/2	TIMING2	Emphasis on application at GS 30 & GS 39/49

The response curves for the treatments, described in terms of TOTAL, TIMING1 and TIMING2, were also estimated by generalised additive models. The models were chosen by a stepwise procedure: the basic model was improved by adding variables or increasing the degrees of freedom associated with the smooth of variables, up to a maximum of three, so as to reduce the mean square error by the greatest amount.

Residuals were calculated for the final models for each plot in order to check the quality of fit of the models. If a high residual was detected the analysis was repeated with the plot omitted. However, it was found that this made little difference to the model.

It was assumed that there were no application costs in applying the fungicide, the only non-fixed overhead being the cost of the fungicide. Hence for the model developed from approach (b) the responses of yield and profit (gross margin/ margin over cost) to changes in timing (TIMING1 and TIMING2) have the same form, only scaled according to the price per ton of the grain. Similarly for the model developed by approach (a) the two responses yield and profit have quadratic dose components of the same form.

From these fitted models, predictions were able to be formed showing the response of yield and gross margin in terms of the three variables.

3.10.2. Exponential curve analysis

As total fungicide dose (total of fungicide applied at each of the three timings of application) increases, yield increases or disease decreases. Typically, the response to fungicide follows a curve with an initial rapid increase or decrease followed by a progressively smaller response to further increases in fungicide. The curves are typical of exponential curves and thus these have been fitted to the data. The shape of the curves are influenced by site, season and disease pressure and thus differ from trial to trial. Since the untreated (nil fungicide) is the point from which the effect of fungicide on yield is judged it is not unreasonable to constrain curves through this point. This is only valid, however, when this anchor point is a solid one and confidence can be placed in it. If full confidence cannot be placed in it then it is best not to constrain the curve through this point but to allow both ends of the curve to move freely. In 1995 and 1996 harvest years, two untreated controls (4 plots) were included as treatments and thus more confidence can be placed in the nil fungicide yield or disease. In 1994 this was not the case. However, examination of curves constrained through zero or otherwise indicated the percent variance accounted for fell rather than rose, thus in the following sections the exponential curves shown are all constrained through nil fungicide.

Exponential curves have the form

$$y = a + b.\ e^{kx}$$

where y = yield,
a = value of upper asymptote (i.e. yield where graph reaches a plateau),
x = fungicide dose,
k = a value that reflects the shape of the curve
b = difference between upper asymptote and untreated yield (a negative value)
Thus a + (-)b = untreated yield

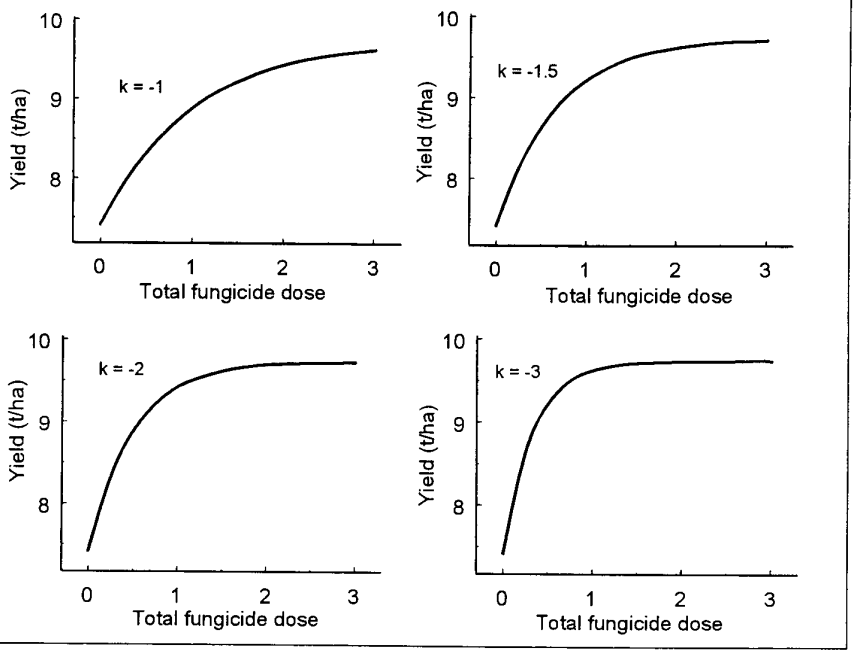
The optimum fungicide dose to achieve maximum yield will vary according to the shape of the curve, that is according to the k value. Fig. 3.1 shows how the shape of the curve changes with different values of k. As the value of k increases the initial rise becomes steeper and the yield plateau more rapidly reached.

[By determining the exponential value of k the equation is sometimes changed to

$$y = a + b.\ r^{x}$$

the value of r also reflects the shape of the curve ($\ln r = k$)]

Fig. 3.1. How changes in k affect the shape of an exponential curve

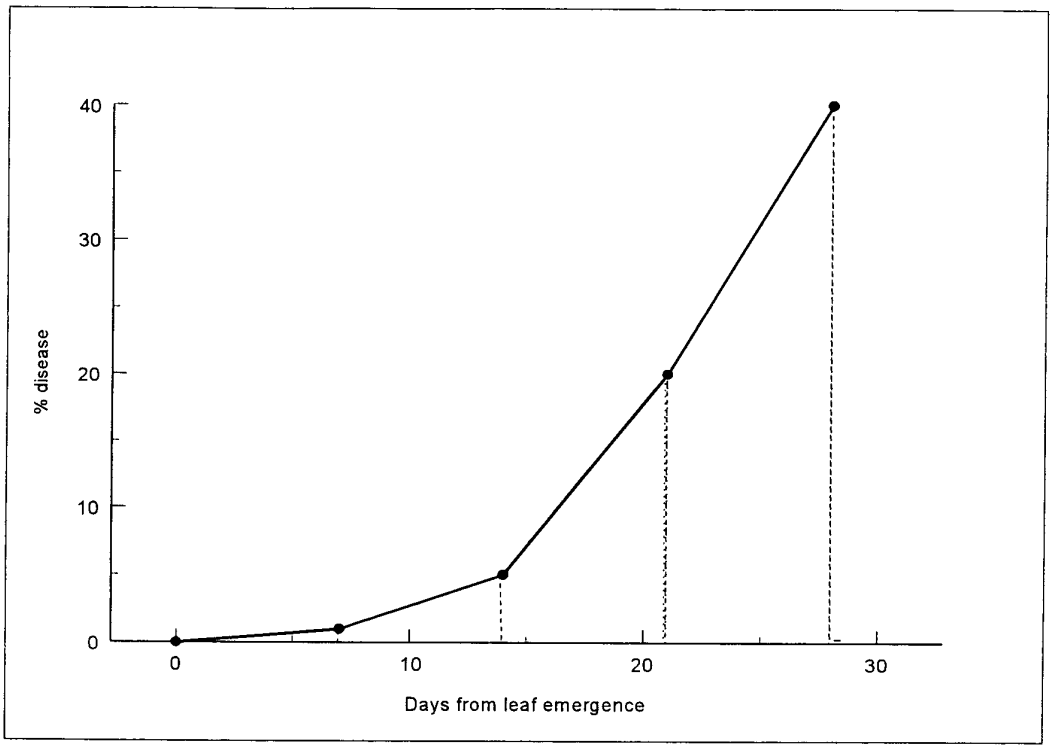


3.11. Analysis of disease - area under disease progress curves

Assessment of each disease present on each leaf layer (as % leaf area infected) were made from late tillering to GS75. For any individual treatment, the progress of disease on each leaf layer can be plotted against time. Comparison of treatments by study of these curves is somewhat cumbersome and impractical. Thus progress of disease on each leaf layer has been expressed through a single value by calculating the area under disease progress curves. This area combines severity and duration of disease.

For example, if a leaf is present for four weeks and the progress of disease as measured at weekly intervals is

Day	0	7	14	21	28
% Disease	0	1	5	20	40



The area under disease this progress curve (AUDPC) is equal to

Sum over weeks 1 to 4 (average disease level * number of days)=
0.5*7 + 3.0*7 + 12.5*7 + 30*7 = 322 percentage days

(Note that over this period the maximum area is 2800 i.e. 100% disease from day 0 to day 28)

Values for AUDPC of each disease accumulated across leaf layers express the total disease impact for that treatment. Subject to there being a reasonable level of disease, total AUDPC assessments for each disease were subjected to a similar form of analysis to that applied to yields.

4. RESULTS

4.1. The development of winter barley

Using the information from regular assessments of disease on all leaves mainly green from GS 30 onwards, it is possible to construct the pattern of development of leaves on the main stem during the period of assessment. Patterns of development for six of the nine trial sites are shown in Figs 4.1a. to 4.1c. Julian date is the day number from January 1st. The figures show that the crop tended to develop later at the Aberdeen site, as would be expected, with GS 69 being reached 10 or more days after other sites. The number of leaves on the main stem fluctuated between two and five. Plant density and the degree of tillering affects the number of leaves on the main stem but the relative number of leaves followed a similar pattern on each crop. The number of leaves at the start of assessment (variously from early to late March, mid to late tillering) was usually 2 or 3. This number was relatively constant until between GS 32 and GS 39 when it rose to 4 to 5. The top 3 or 4 leaves persisted until grain filling when leaves 3 and 4 senesced.

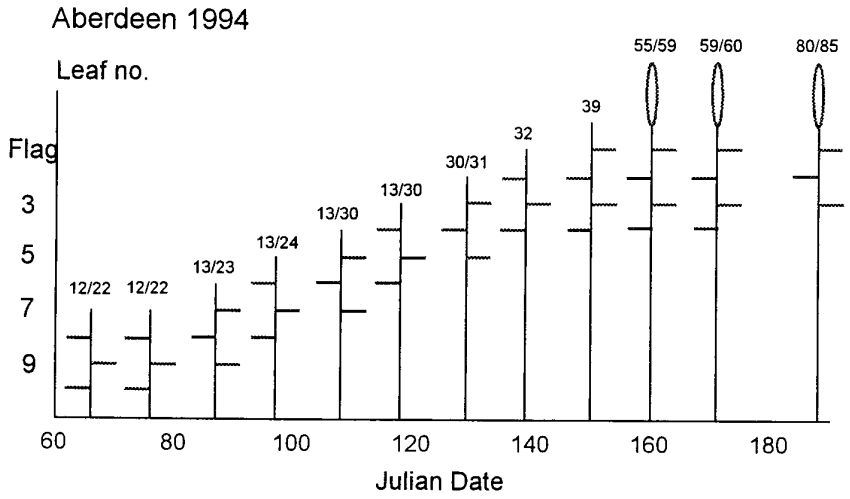
Most frequently, the top leaf at GS 32 was the ultimate third top leaf (leaf 3). The top leaf at GS 31 was the ultimate fourth or fifth top leaf.

It is not possible to tell exactly the duration of particular leaf layers but an indication of relative persistence is possible. The average duration of the top seven leaves were:

Leaf	Duration (days)
1 (flag)	35+
2	43+
3	44
4	40
5	23
6	22
7	26

Where a number is followed by a plus sign, this means that the leaf was still green at the last assessment and it duration may be longer than this figure suggests. The top four leaves appear to be present for a period of about six weeks each. Leaves 5, 6 and 7 present at or just before GS 31 have a duration almost half that of the top four leaves. The contribution of these lower leaves with a rapid turn-over is uncertain but leaves 5 and 6 are present at GS 31, considered the most important timing for winter barley and it is interesting to speculate whether prolongation of their life as a result of disease control at this time is important to final yield.

Figure 4.1.a. Development of winter barley with time in six trial sites



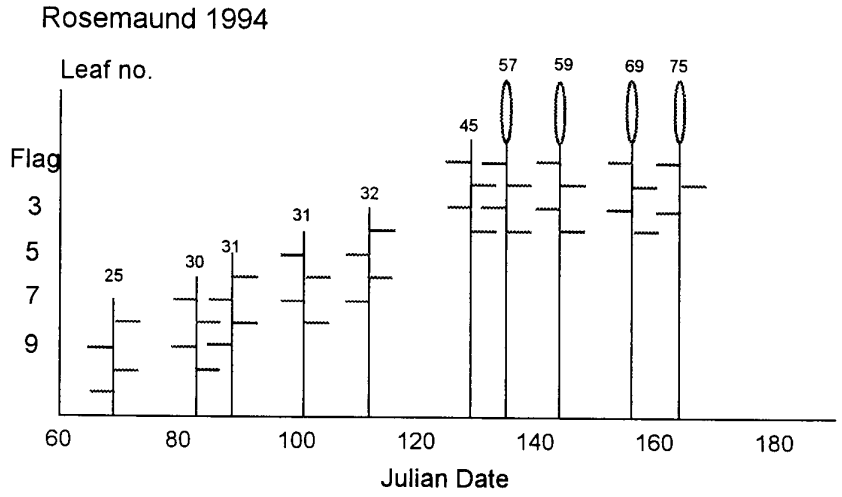
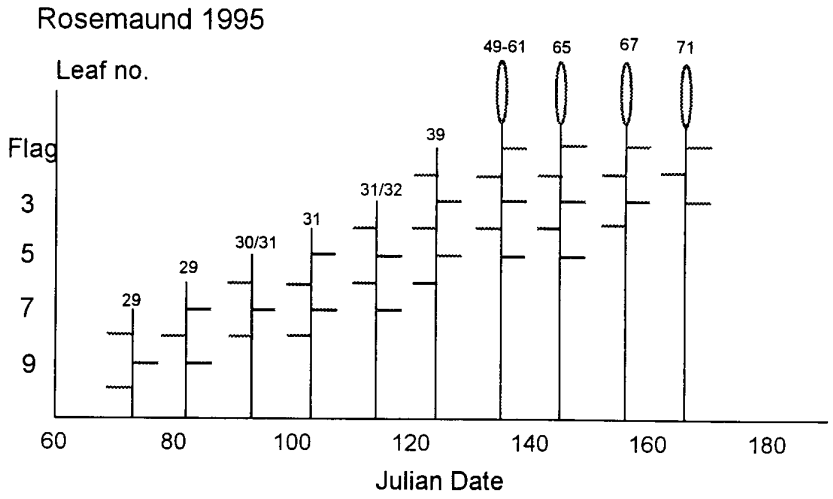


Figure 4.1.b. Development of winter barley with time in six trial sites



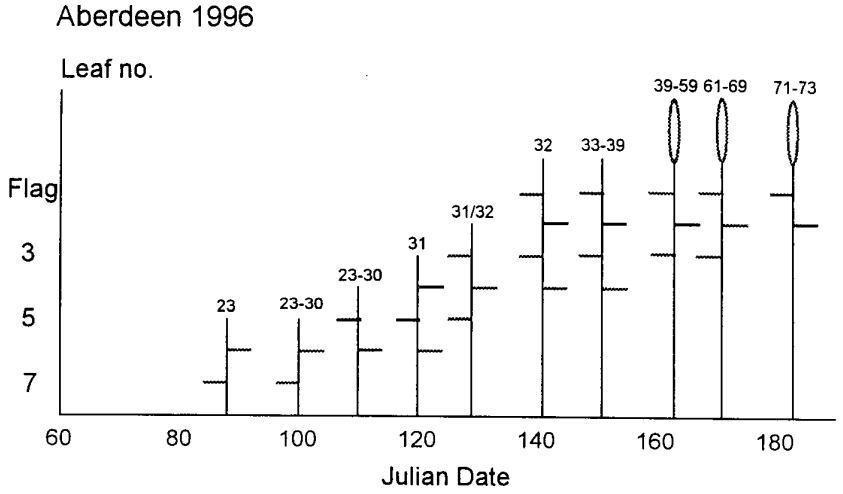
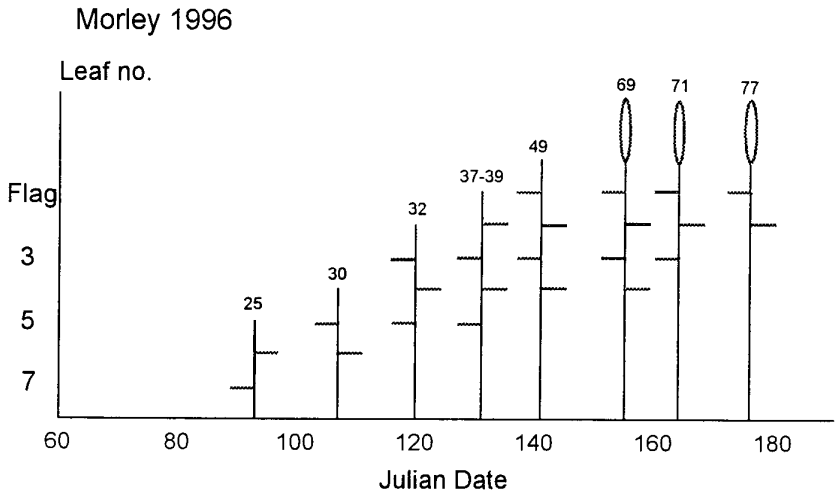
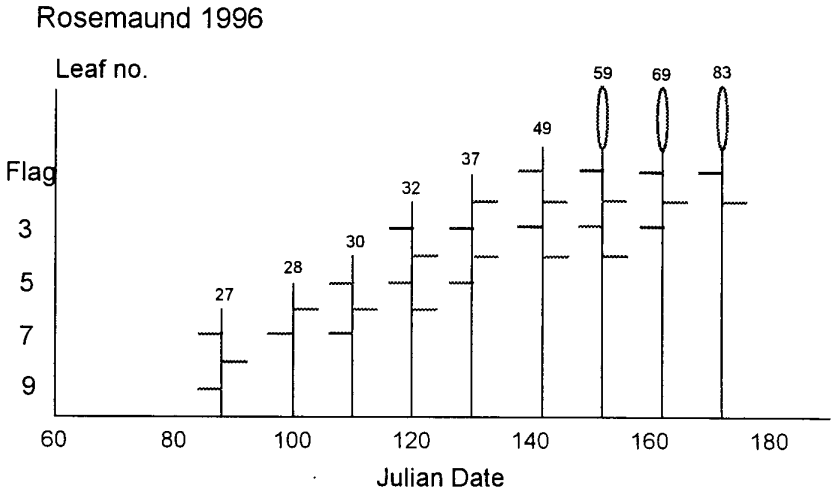


Figure 4.1.c. Development of winter barley with time in six trial sites





4.2. Yield response to fungicide

4.2.1. Effect of total fungicide dose on yield - exponential curve analysis

Yield data from all nine trials are presented here. The trial at Rosemaund in 1995 was affected by take-all and the yields must be considered with caution. The yields at 15% moisture content for each trial are given in Appendix 1 as actual means and as adjusted means corrected to allow for underlying variation in soil fertility. The standard error for each adjusted mean is also given. In the following, only results for the adjusted means are used.

Yields at each site increased as the total fungicide dose (total of fungicide applied at each of the three timings of application) increased. As expected at low disease sites the response was small, there was a steep rise in yield initially, levelling off to a plateau where increases in fungicide dose had very little effect on yield. At sites where the disease pressure was moderate to high the increase in yield was steady as total fungicide dose increased. A plateau was reached much later than in low disease sites where an increase in dose had little effect on yield.

The yield curves for the nine trials are shown in Figs. 4.2., 4.3. & 4.4. with their exponential equations. Each curve represents the average yield response for a series of total fungicide doses. At each total fungicide dose, the mean is comprised of treatments with one, two or three fungicide applications. The curves do not therefore take into account timing and its relative contribution to yield.

Low disease levels resulted in small yield responses (Table 4.1) at Aberdeen 1994, Morley 1994, Rosemaund 1995 and Morley 1996. At each of these sites yield responses were only of the order of 0.3 - 0.4 t/ha. In 1994, the Aberdeen and Morley sites achieved the maximum response to fungicide at 1.0 to 1.25 total fungicide dose. The same point was reached at Rosemaund 1995 and Morley 1996 at around 0.5 total fungicide dose.

Table 4.1. Components of exponential curve equations for yield versus total fungicide dose

Site	a	b	k	Yield response at total dose = 3
Aberdeen 1994	8.63	-0.33	-2.73	0.33
Morley 1994	5.37	-0.41	-3.51	0.41
Rosemaund 1994	8.68	-2.36	-0.60	1.97
Aberdeen 1995	10.19	-2.13	-0.61	1.78
Morley 1995	8.49	-3.28	-0.96	3.10
Rosemaund 1995	6.05	-0.44	-7.37	0.44
Aberdeen 1996	9.38	-1.95	-1.38	1.92
Morley 1996	7.35	-0.43	-6.64	0.43
Rosemaund 1996	9.23	-1.29	-1.44	1.27

In the remaining five trials, disease levels ranged from moderate to high and yield responses were all greater than 1.0 t/ha. The shape of the curves relating total fungicide dose to yield for Aberdeen 1996 and Rosemaund 1996 were similar. The yield in these trials reached a plateau, the maximum yield being approached with a total fungicide dose of 2.0. By contrast, in the other three trials, the yield increased with dose not reaching a plateau even at a maximum total fungicide dose of 3.0.

4.2.2. Surface response analysis

The contribution of fungicide timing to yield was determined by the application of surface response analysis to the data. This analysis examined the effect of timing on yield and determined the most efficient model for each site. Only models developed for approach a) (see Materials and Methods, section 3.10.1) are presented. The models are given below in Table 4.2. and the tables of calculated yields given in Appendix 2.

The surfaces calculated by this method are not anchored at the zero fungicide point and thus the values calculated in them do not exactly correspond to the original adjusted means or those in the exponential graphs. The surfaces are not as easy to interpret as the exponential graphs.

By analysing the data using the alternative method where treatments were re-parameterised (approach b) in Materials and Methods, section 3.10.1), it was evident that most variation in yield was due to the total amount of fungicide applied and the timing was of less importance. (It is important, however, to recognise the wide range of dose levels applied and to note that responses were generally observed at more than one date. Given a narrower range of doses the timing would become relatively more important). Despite this, it is necessary to look further at which timings and doses contribute most to yield. However, taking the total fungicide dose from the optimum fungicide programmes from surface response analysis allows comparisons to be made with the results from exponential curve analysis.

The optimum programme of doses for the three fungicide timings for each trial and consequent total fungicide dose are shown in Table 4.3 along with the optimum total fungicide dose determined by applying exponential curve analysis. If the five trials with moderate to severe disease are examined first, the optimal total fungicide dose determined by surface response analysis is consistently less than that suggested from exponential curve analysis. This can be explained by the fact that exponential curves follow the average responses for each total fungicide dose. For any particular total dose, if one combination of doses at three timings is more effective than others it will not be apparent. Apart from Rosemaund 1996 where the optimum total fungicide dose determined by surface response analysis was 1.25 below that determined from the exponential curve analysis, the optimum total fungicide dose for the other sites with moderate to severe disease were just 0.25 to 0.5 lower. The disparity at Rosemaund in 1996 was possibly because this site had the lowest yield response (1.27 t/ha) of the five sites with moderate to severe disease. Surfaces for these five sites are shown in Figures. 4.5 and 4.6.

The optimum total fungicide dose at the four low disease sites as determined by surface response analysis were greater than or equal to that determined from exponential curves. However, the surfaces for these trials were very flat and small

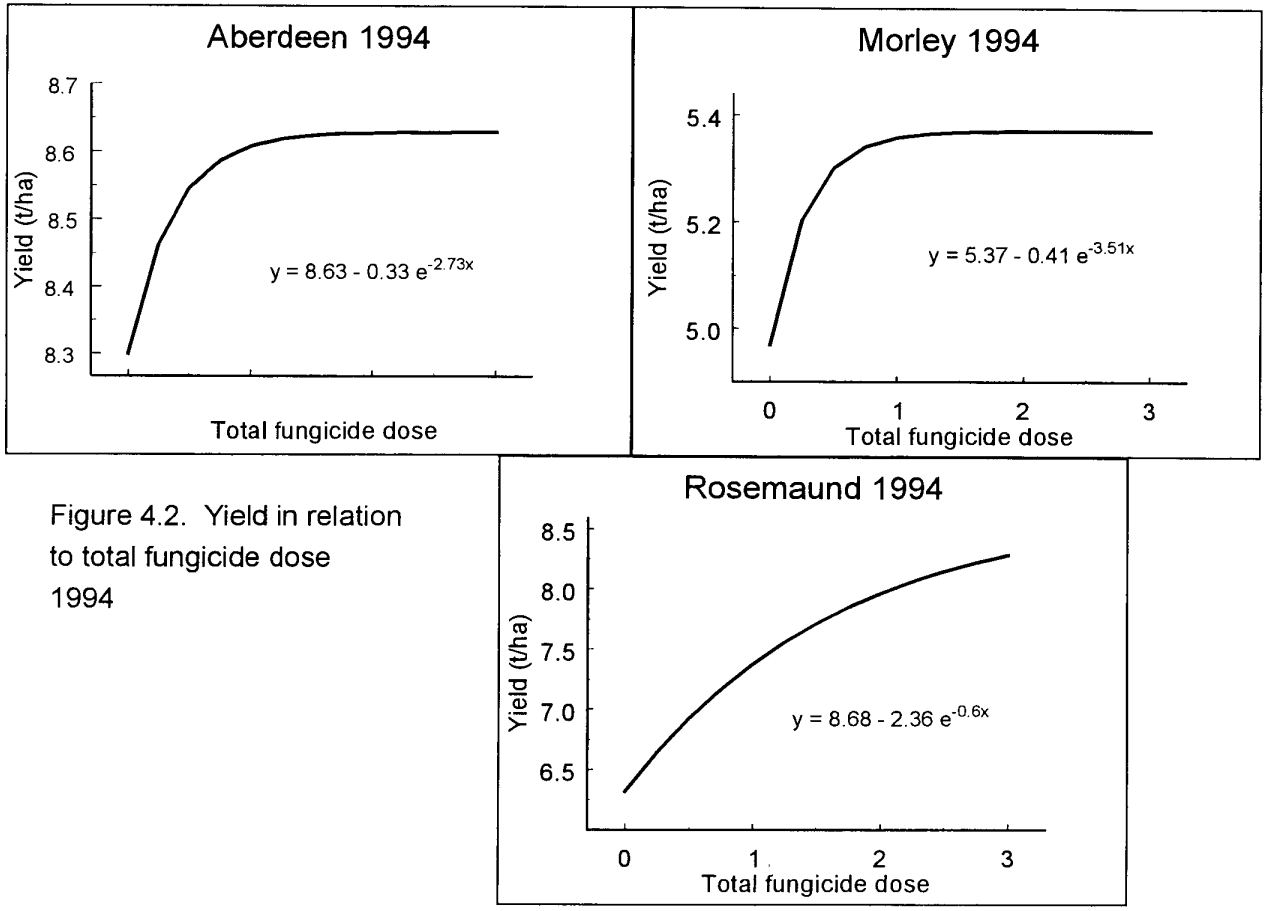


Figure 4.2. Yield in relation to total fungicide dose 1994

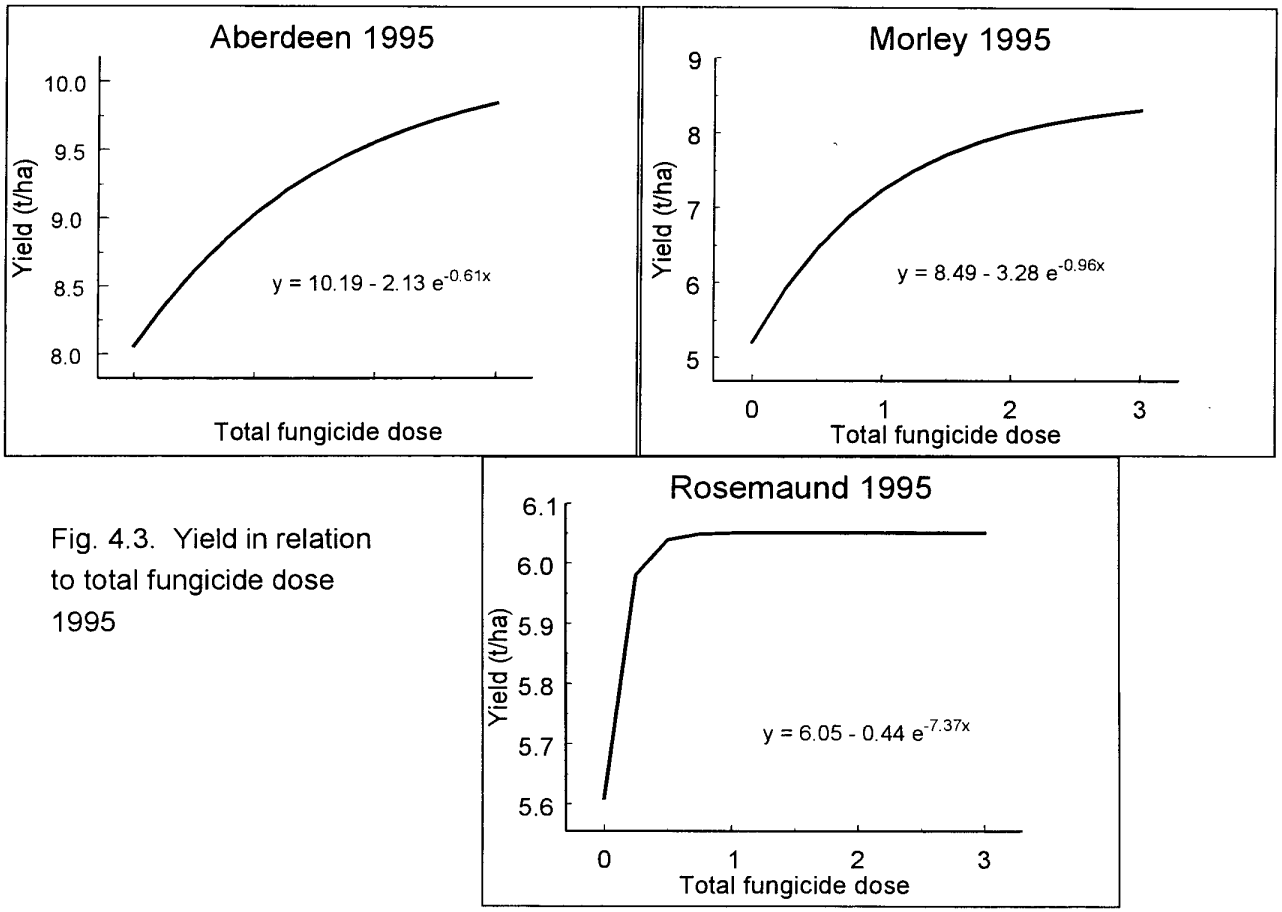


Fig. 4.3. Yield in relation to total fungicide dose 1995

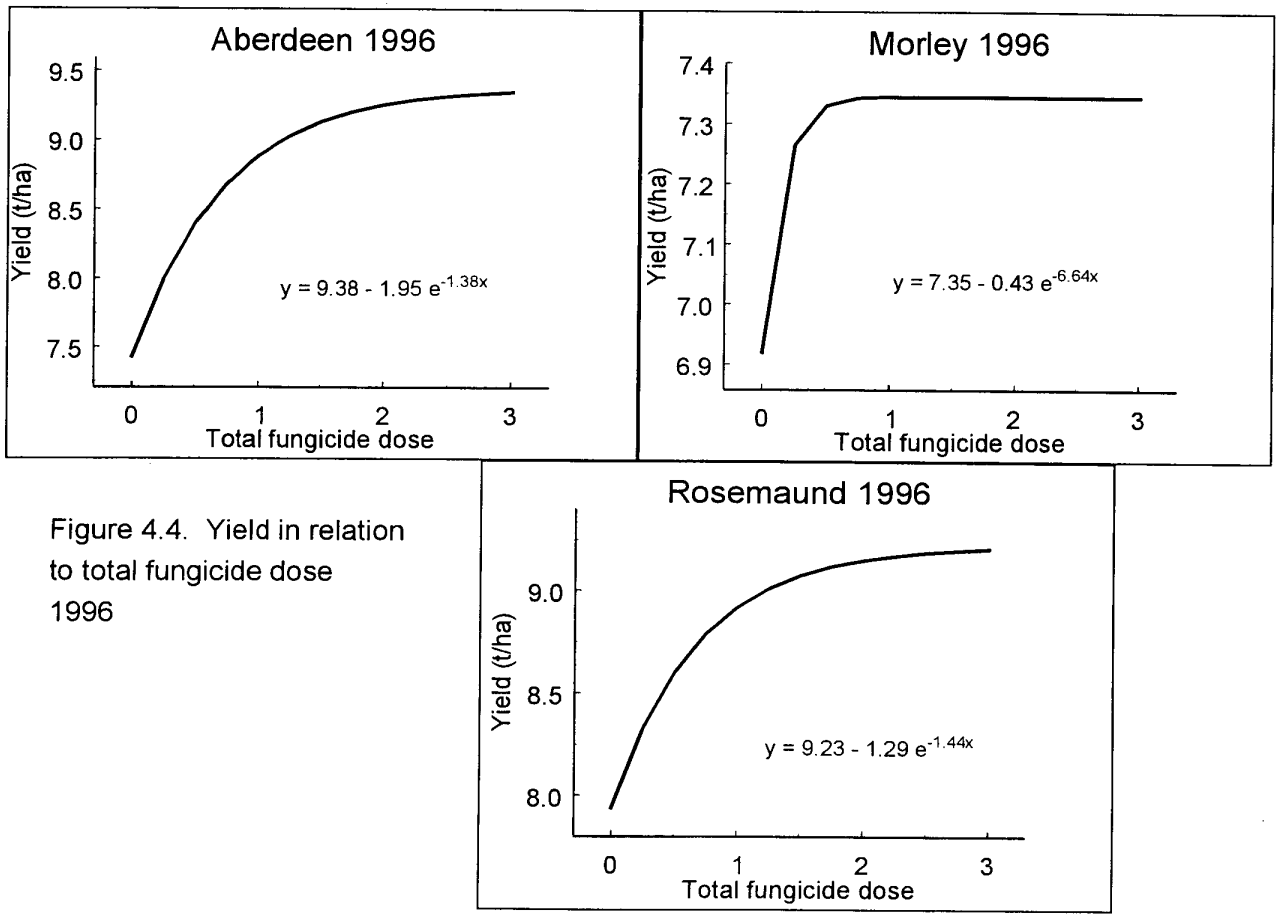


Figure 4.4. Yield in relation to total fungicide dose 1996

Table 4.2. Best fit models in surface response analysis of yield against fungicide dose and timing.

Site	c	GS30	GS31	GS39	GS3030	GS3131	GS3939	GS3031	GS3039	GS3139	% variance accounted for
Aberdeen 1994	8.490	0.0153	0.0446	-0.006	-0.0076	0.0212	0.0292				0
Morley 1994	5.492	0.0165	0.0188	0.0039	-0.0188	-0.0126	-0.0158				9.7
Rosemaund 1994	7.684	0.1652	0.0246	-0.0002	0.0443	0.0469	-0.0808				14.0
Aberdeen 1995	9.411	0.0635	0.2314	0.1869		-0.1002					73.6
Morley 1995	8.023	0.1690	0.2683	0.2050	-0.0620	-0.1152	-0.0642	-0.0476	-0.0081	-0.0281	95.4
Rosemaund 1996	6.181	-0.0450	0.0222	-0.0118	-0.0646			-0.0278		-0.0263	15.2
Aberdeen 1996	9.189	0.0632	0.2455	0.1629			-0.0867		-0.0436		78.3
Morley 1996	7.503	0.0226	0.0320	0.0118	-0.0153	-0.0394	-0.0315				15.5
Rosemaund 1996	9.069	0.0156	0.1282	0.0890		-0.0475		-0.0343	-0.0496		74.8

Table 4.3. Comparison of optimum fungicide programme and total fungicide dose for yield determined by surface response analysis with the optimum total fungicide dose determined by exponential curve analysis

Site	Optimum fungicide programme determined by surface response analysis. Dose at:				Exponential curve analysis
	GS 30	GS 31/32	GS 39/49	Total fungicide dose	Total fungicide dose
Aberdeen 1994	0.75	1.0	0	1.75	1.75
Morley 1994	0.5	0.75	0.5	1.75	1.25
Rosemaund 1994	1.0	1.0	0.5	2.5	3.0
Aberdeen 1995	1.0	0.75	1.0	2.75	3.0
Morley 1995	0.75	0.75	0.75	2.25	2.75
Rosemaund 1995	0.5	1.0	0	1.5	0.75
Aberdeen 1996	1.0	1.0	0.5	2.5	2.75
Morley 1996	0.75	0.5	0.5	1.75	0.75
Rosemaund 1996	0	0.5	1.0	1.5	2.75

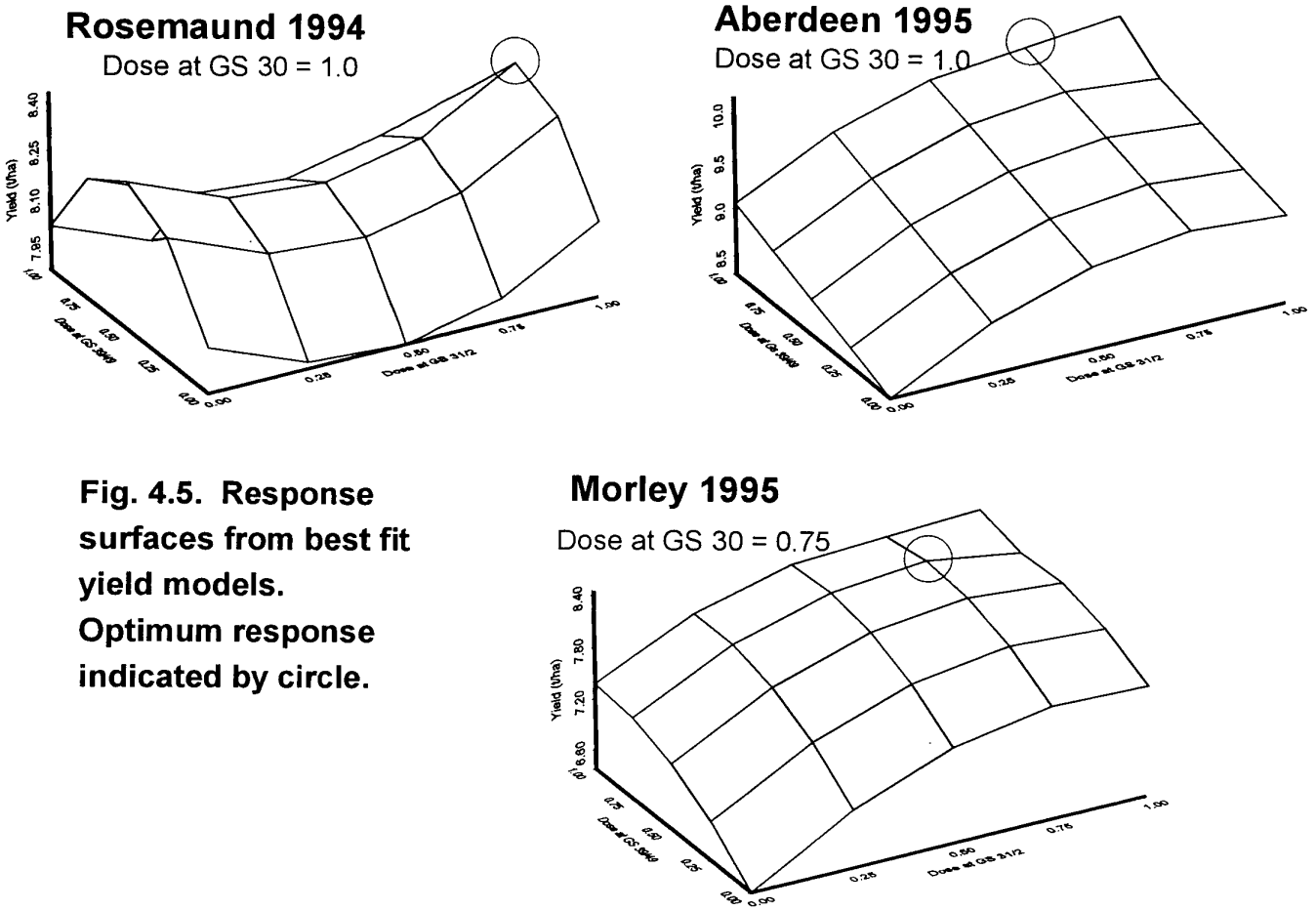
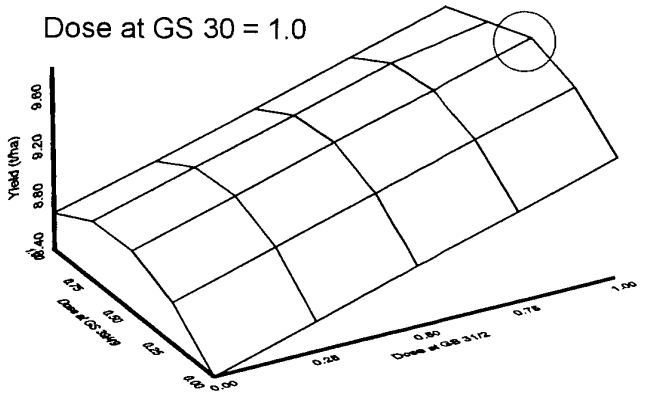


Fig. 4.5. Response surfaces from best fit yield models. Optimum response indicated by circle.

Aberdeen 1996



Rosemaund 1996

Fig. 4.6. Response surfaces from best fit yield models. Optimum response indicated by circles

differences in yield apparent between widely varying total fungicide doses. Where such flat surfaces exist the confidence that can be placed in the optimum being accurate must be less. The percentage variance accounted for in surface response analysis at the four low disease sites is low (Table 4.2). In low disease situations, the exponential curve probably indicates the optimum total fungicide dose for yield more realistically.

In examining the interaction of total fungicide dose and yield on the susceptible variety Pastoral, where the disease pressure was moderate to high (Aberdeen 1995, 1996, Morley 1995, Rosemaund 1994, 1996) and the yield response large, a total fungicide dose in excess of 2 full doses was required for optimum yield. With low disease, low yield response sites, under one full dose was usually sufficient to achieve maximum yield.

4.2.3. The effect of timing and number of fungicide applications on yield

Taking the adjusted yields from the 39 treatments and the IDR treatment evaluated in each trial (Appendix 1), comparisons can be made of the yield resulting from the same total fungicide dose where it has been made in 1, 2 or 3 applications. Table 4.4 gives the results of these comparisons for the five sites with moderate to severe disease.

Table 4.4. Mean yields resulting from applying one full fungicide dose in 1, 2 or 3 applications

	Average yield at a total fungicide dose of 1 Number of applications			UT yield
Site	1	2	3	
Rosemaund 1994	7.20	7.46	8.20	6.28
Aberdeen 1995	8.39	8.91	8.75	8.06
Morley 1995	6.66	7.23	7.54	5.21
Aberdeen 1996	8.56	8.70	8.85	7.43
Rosemaund 1996	8.67	8.89	8.89	7.94
Average	7.90	8.24	8.45	6.98

Although the number of treatments contributing to the means in Table 4.4 differ between 1,2 and 3 applications they represent all but one possible combination of doses to apply 1.0 fungicide dose. It is clear that for this total fungicide dose at least, splitting the yield into three applications usually achieved a better yield.

Timing effects can be ascertained in a number of ways. Of the 39 treatments in each trial a single application of 0.25, 0.5 0.75 and 1.0 were applied in each trial at each of the three timings. By taking a mean of the four doses, the yield response to a single application at the three timings can be determined. In most circumstances, a single application at GS 31/2 resulted in the greatest yield response. Yield responses at GS 30 and GS 39/49 were similar in four trials but differed in the fifth (Aberdeen 1996 - Table 4.5).

Table 4.5. Mean responses to single fungicide applications at each of three timings

	Average yield to single fungicide applications at:			UT yield
Site	GS 30	GS 31/2	GS 39/49	
Rosemaund 1994	6.91	7.07	6.96	6.28
Aberdeen 1995	8.35	8.91	8.37	8.06
Morley 1995	6.34	6.89	6.21	5.21
Aberdeen 1996	8.14	8.54	8.65	7.43
Rosemaund 1996	8.53	8.74	8.55	7.94
Average	7.65	8.03	7.75	6.98

An examination of the equations for the surface response analysis for yield (Table 4.2) indicates that GS 31/2 applications had the greatest effect on yield. However, the contribution to yield from the GS 30 and GS 39/49 applications varied from trial to trial.

Current accepted wisdom is that GS 31/2 is the most important timing followed by GS 39/49 but few trials have sought to evaluate whether fungicide at GS 30 can contribute to yield response. The results above suggest that it can. The optimum fungicide programmes for eight out of nine sites (Table 4.3) indicate that fungicide applications at GS 30 are effective in optimising yield. Another way to evaluate this is to examine the yield responses of the 39 treatments and the IDR treatment for comparable programmes with and without a GS 30 application. For the five trials where disease pressure was moderate to high, the average contributions to yield from GS 30 applications were variable (Table 4.6).

Table 4.6. Average responses to an application at GS 30 in comparable programmes with and without this timing.

Site	Average response t/ha	No. comparisons	Comment on comparisons
Rosemaund 1994	0.11	8	variable
Aberdeen 1995	-0.27	8	mostly negative
Morley 1995	0.49	9	all positive
Aberdeen 1996	0.15	8	variable
Rosemaund 1996	-0.14	9	variable

Assessed in this way, the benefit of GS 30 application is inconsistent and thus requires judgement. From the trials in this series, in yield terms, it appears to be of most benefit where early disease is severe or where a disease like brown rust is present that has the potential to explode later. The effect of a GS 30 fungicide application is to reduce inoculum at an early stage of growth and thereby prevent or delay disease development later. It seems likely that one effect of a GS 30 application is to make the GS 31/2 application more effective. It may be also that crops with a low green leaf area index also respond well to early disease control for any loss of green leaf area around the key timing of GS 31/2 could significantly influence the ability to absorb light for photosynthesis.

4.3. The effect of total fungicide dose on grain quality

At all sites grain quality was measured as thousand grain weight (TGW) and specific weight (SpWt). Not surprisingly, both characters improved linearly as the yield increased and since yield increased with fungicide dose, a linear relationship was also established between total fungicide dose and these quality characters.

The slopes of the relationship between TGW or SpWt and total fungicide dose are shown in Figs. 4.7 to 4.12. Increases in TGW for each unit of fungicide dose are shown in Table 4.7. At those sites where disease was low, the increase was small or even slightly negative. With moderate to severe disease sites, the increase in TGW was mostly more than 1g per unit of fungicide, especially at Morley 1995 where the increase approached 3g. Increases in SpWt followed the pattern for TGW except that increases at the moderate to severe disease sites were under 1 kg/hl, except again at Morley 1995. The steep regression lines for Morley 1995 probably reflect that brown rust was the principal disease and this infected awns as well as leaves resulting in a greater effect on grain quality.

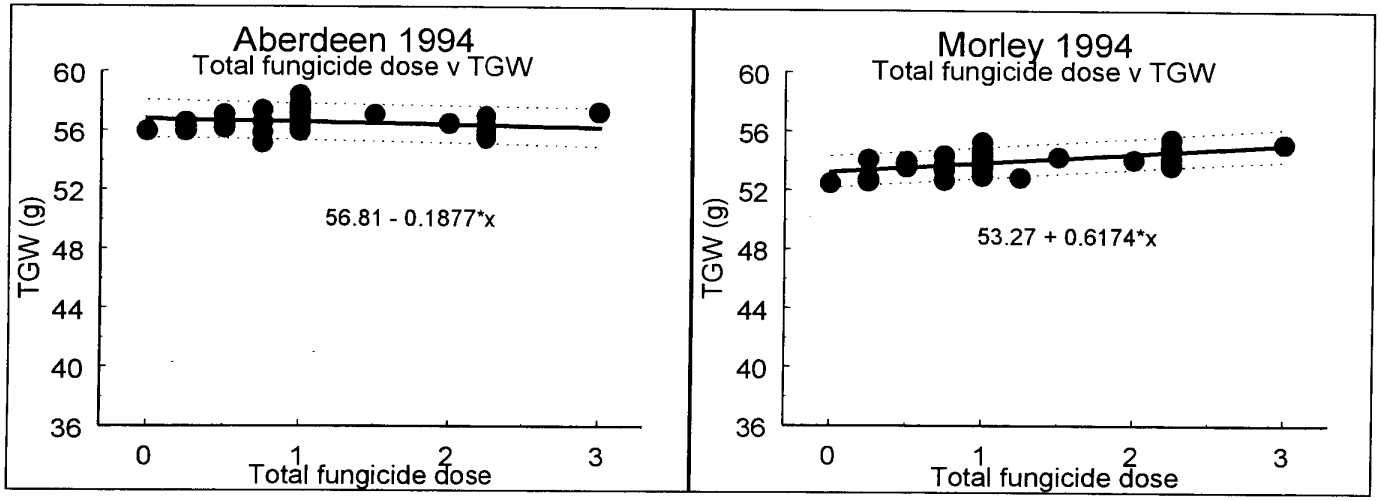


Fig. 4.7. Linear regression of thousand grain weight with total fungicide dose.
1994
Dots indicate 90% confidence intervals

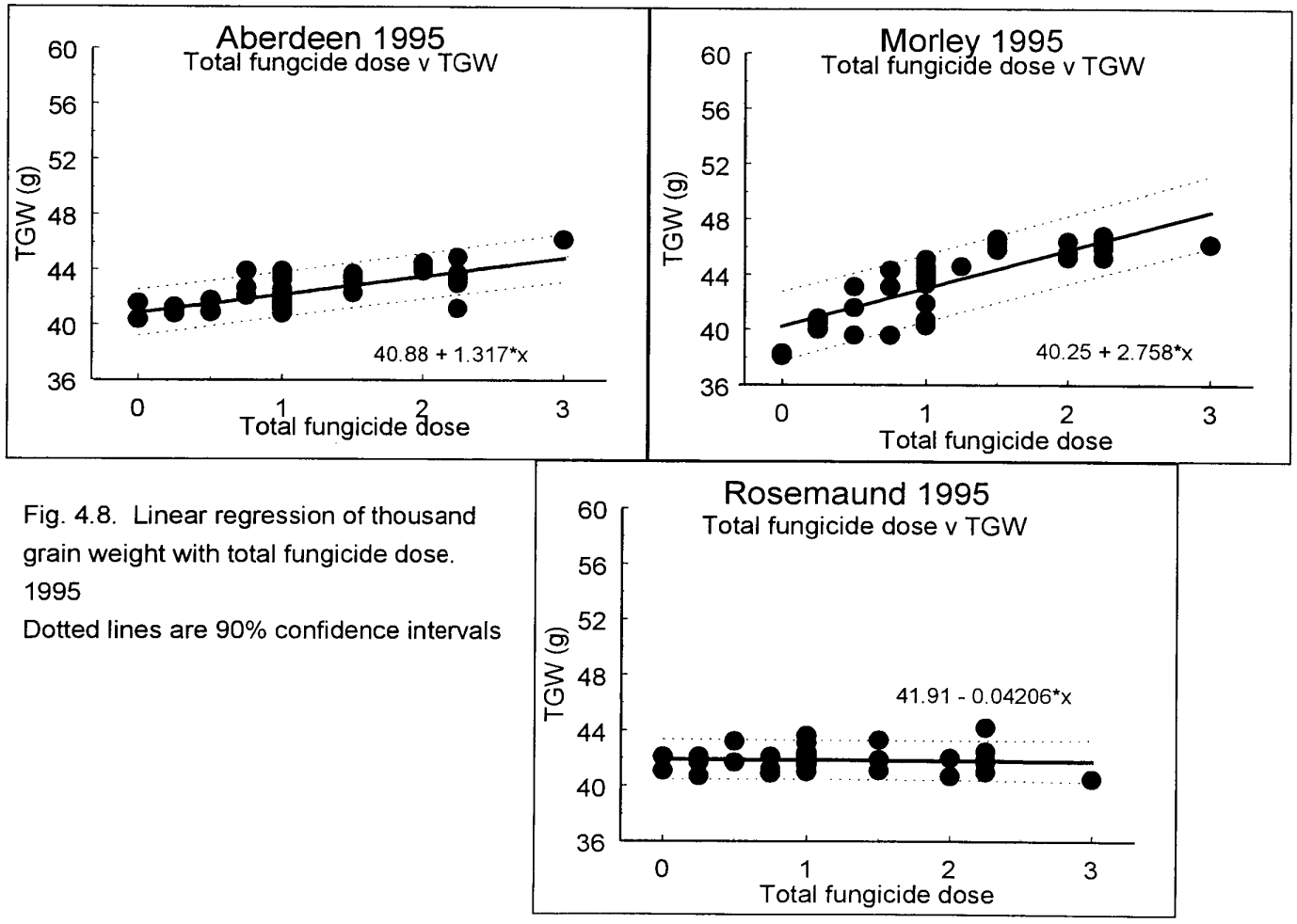


Fig. 4.8. Linear regression of thousand grain weight with total fungicide dose. 1995
Dotted lines are 90% confidence intervals

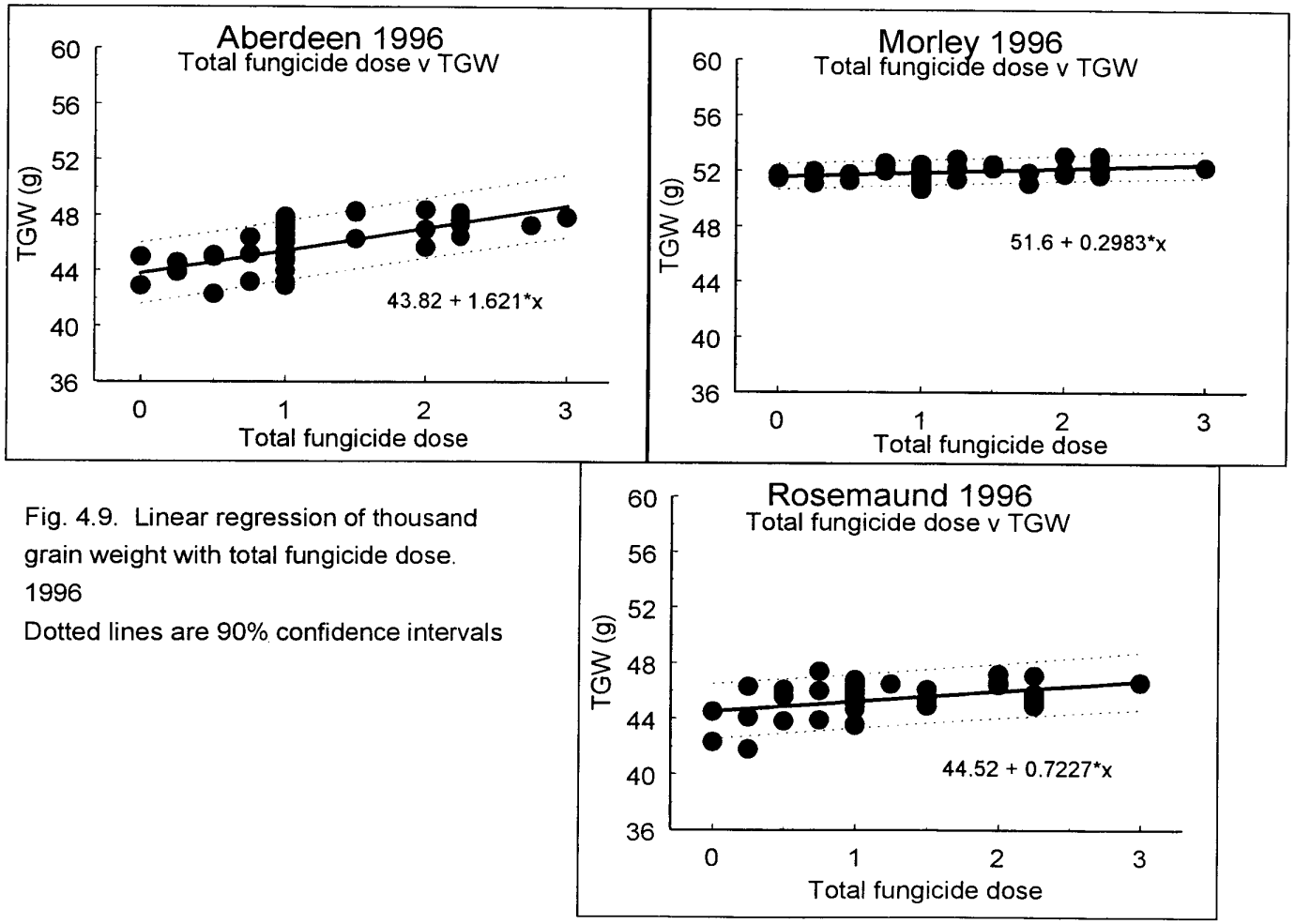
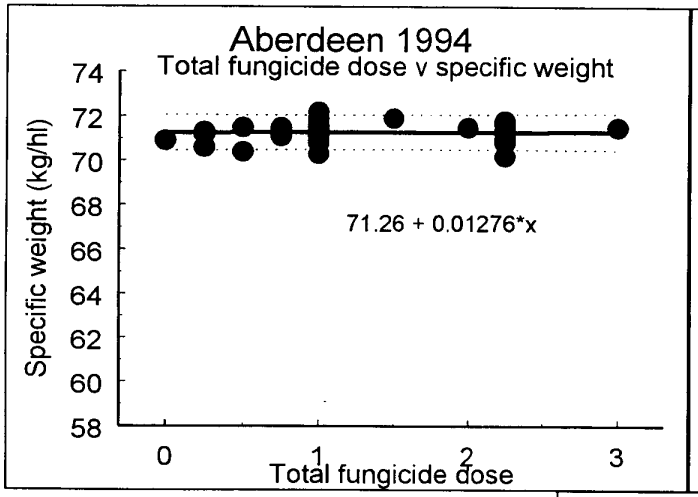
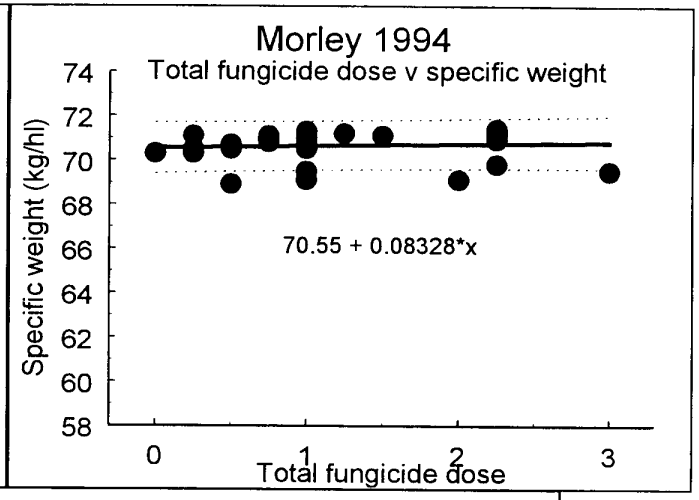


Fig. 4.9. Linear regression of thousand grain weight with total fungicide dose. 1996
Dotted lines are 90% confidence intervals





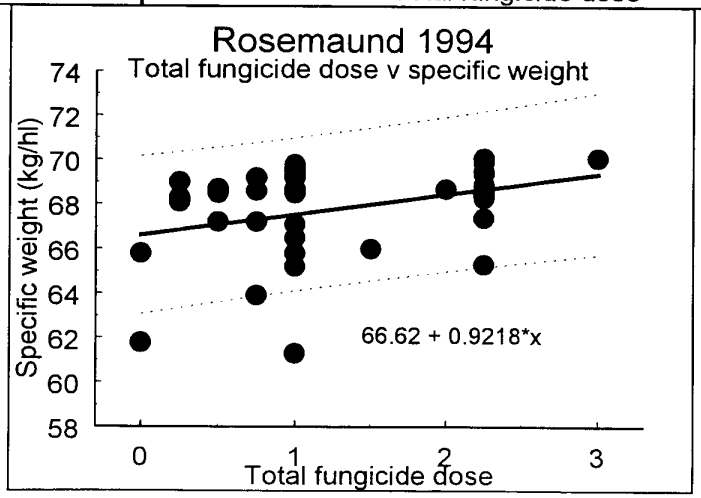


Fig. 4.10. Linear regressions of specific weight with total fungicide dose.
1994.
Dotted lines are 90% confidence intervals

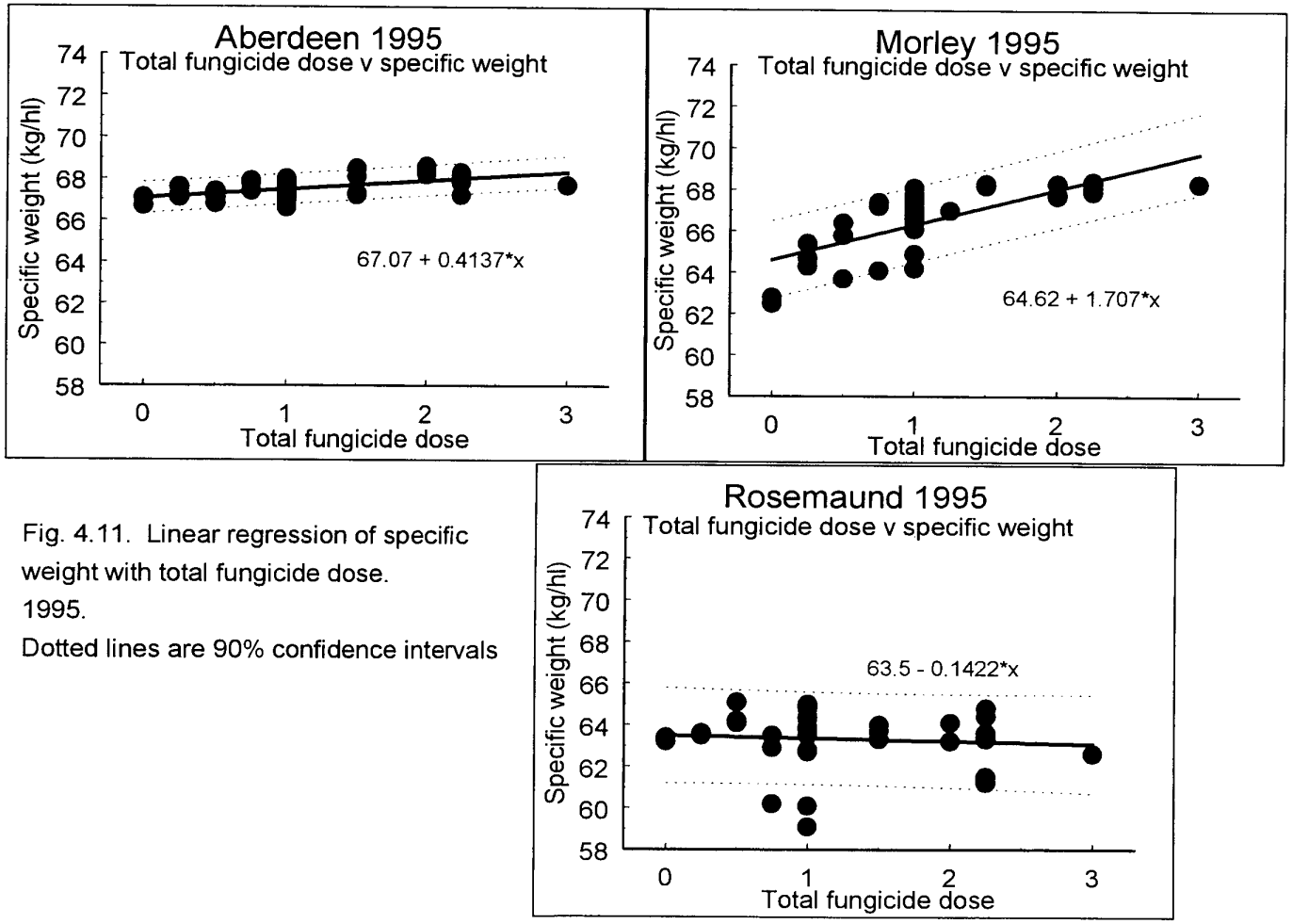


Fig. 4.11. Linear regression of specific weight with total fungicide dose.
1995.
Dotted lines are 90% confidence intervals

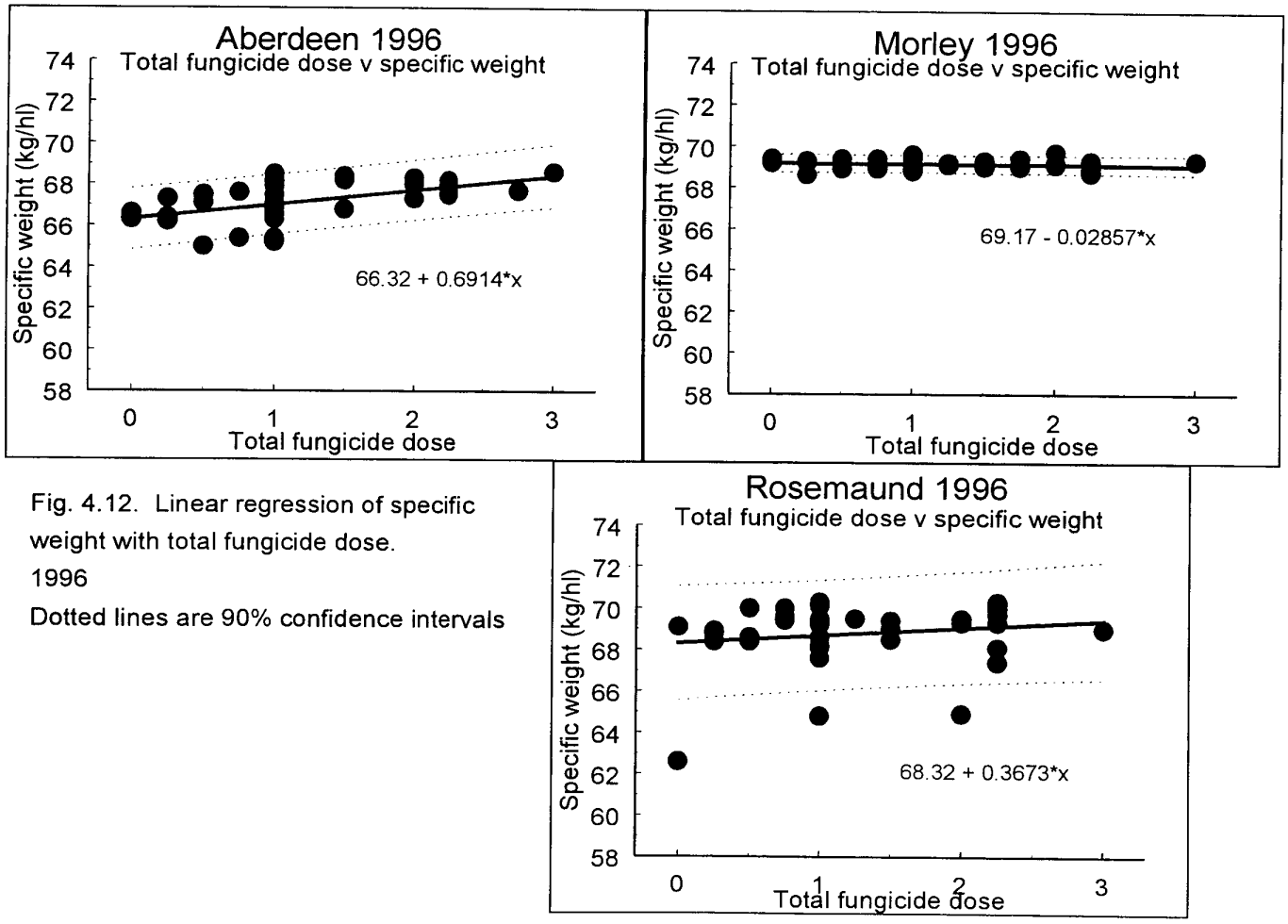


Fig. 4.12. Linear regression of specific weight with total fungicide dose.
1996
Dotted lines are 90% confidence intervals

Table 4.7. Increase in thousand grain weight and specific weight for a unit increase in fungicide dose.

Site	Increase for each unit of fungicide dose	
	Thousand grain weight - g	Specific weight - kg/hl
Aberdeen 1994	-0.19	0.01
Morley 1994	0.62	0.08
Rosemaund 1994	-	0.92
Aberdeen 1995	1.32	0.41
Morley 1995	2.76	1.71
Rosemaund 1996	-0.04	-0.14
Aberdeen 1996	1.62	0.69
Morley 1996	-0.30	-0.03
Rosemaund 1996	0.72	0.37

4.4. The effect of total fungicide dose on disease

A range of disease epidemics occurred at the nine sites but because the variety Pastoral was used at each site their effects could be inter-related. Although a highly susceptible variety, disease was not always severe and low disease sites are valuable in that they provide as much an insight into when and how much fungicide to apply as moderate or high disease sites. The option to select different varieties at specific sites to target different diseases was considered but rejected because this would not permit as much cross site comparison.

Although assessments were made on all plots at 10 day intervals and it would be possible to use percentage leaf area infection as a measure (understood by many) of the effectiveness of different fungicide programmes, this measure of disease only permits snapshots of an epidemic to be evaluated. The integration of disease with time on any leaf layer and expressed as AUDPC permits greater flexibility of analysis - although the values of AUDPC are less readily interpreted in a practical sense. Values of AUDPC for all treatments at each site and for each leaf layer are given in appendix 3.

Total fungicide dose and AUDPC for disease on leaves 1 to 4 or total disease on the top five or seven leaves was highly correlated (r = -0.5 or greater). Also examination of correlation coefficients between yield and total disease on leaf layers (Appendix 4) shows that correlation was greatest with total disease on leaves 2 and 3 and the total disease on the top 5 leaves. To examine the effect of total fungicide dose on disease, therefore, exponential curves analysis was carried out for total disease as AUDPC on leaf 2 and the top 5 leaves, with the zero forced through the untreated value.

The curves for each site are shown in figures 4.13 to 4.15 (AUDPC leaf 2) and figures 4.16 to 4.18 (AUDPC top 5 leaves). Taking the latter, it was noticeable that disease was reduced to minimal levels (c AUDPC of 200) by up to 3 full doses of fungicide. At the two sites where disease was most severe, even the highest total fungicide dose failed to reduce the AUDPC below 1000.

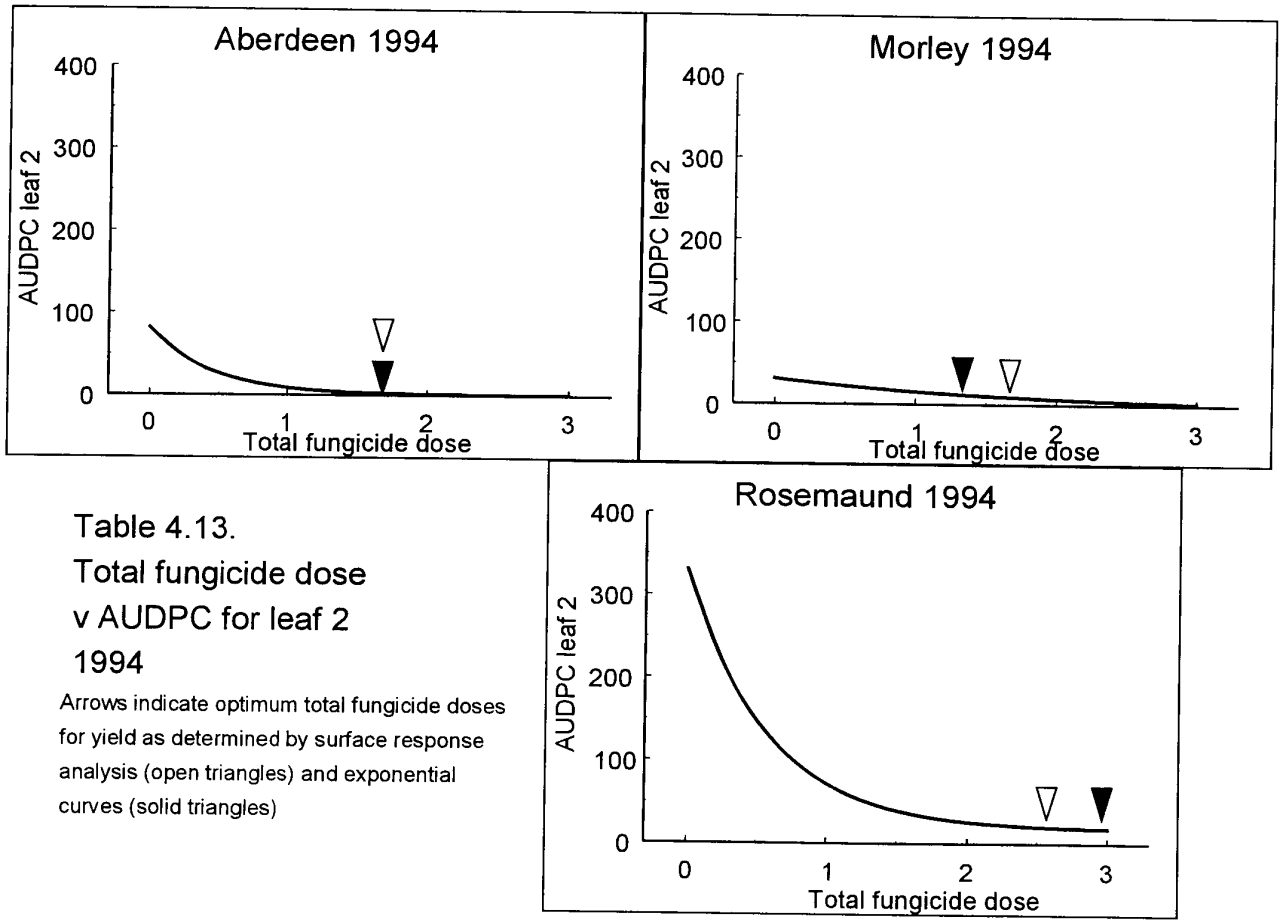


Table 4.13.
Total fungicide dose
v AUDPC for leaf 2
1994

Arrows indicate optimum total fungicide doses for yield as determined by surface response analysis (open triangles) and exponential curves (solid triangles)

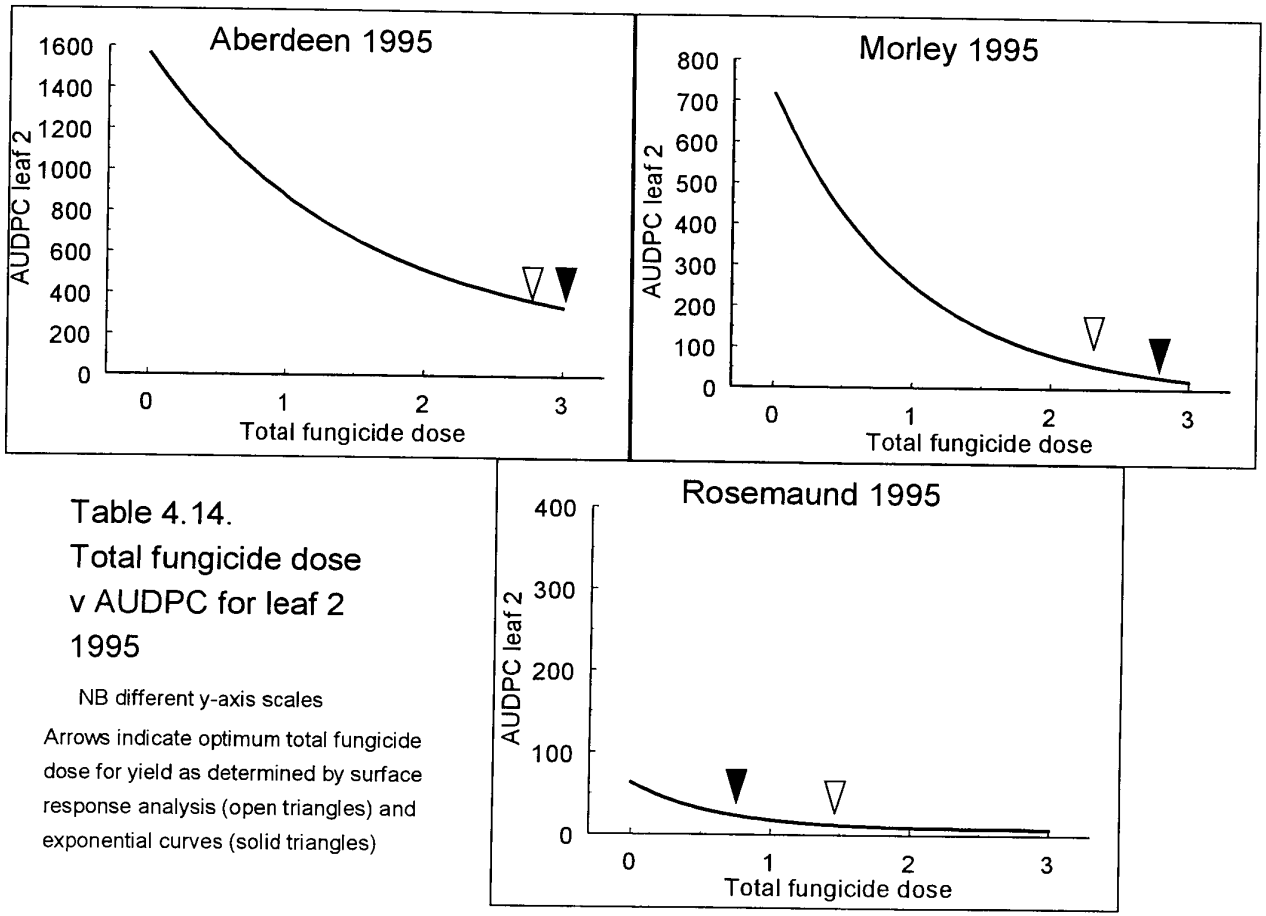


Table 4.14.
Total fungicide dose v AUDPC for leaf 2 1995

NB different y-axis scales

Arrows indicate optimum total fungicide dose for yield as determined by surface response analysis (open triangles) and exponential curves (solid triangles)

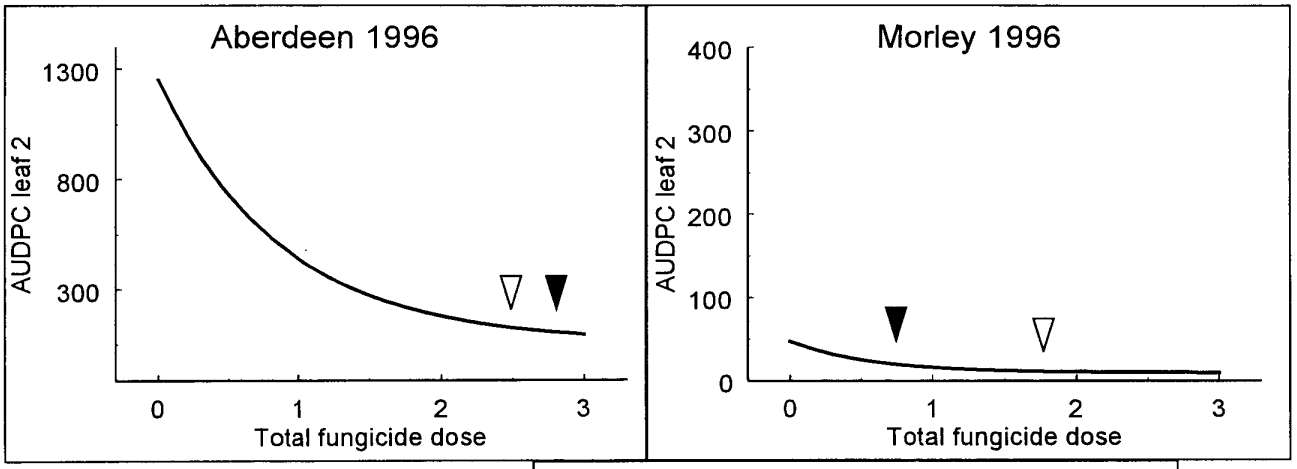
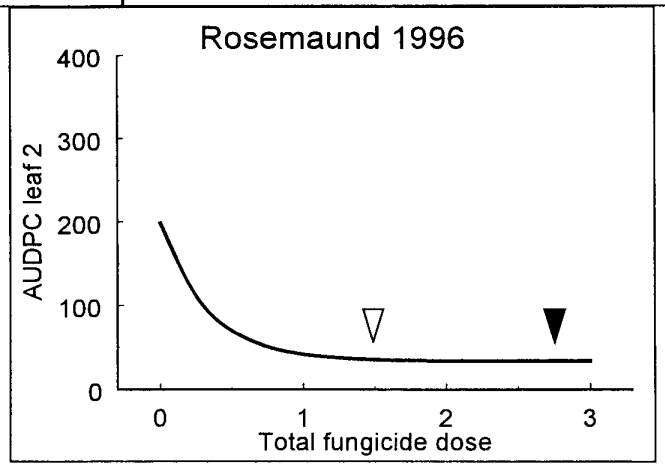
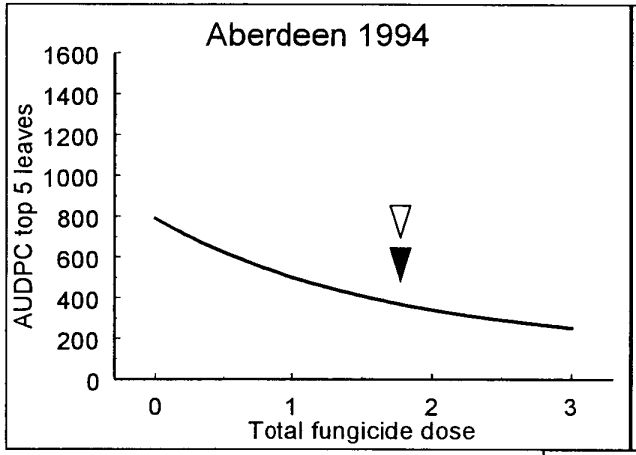


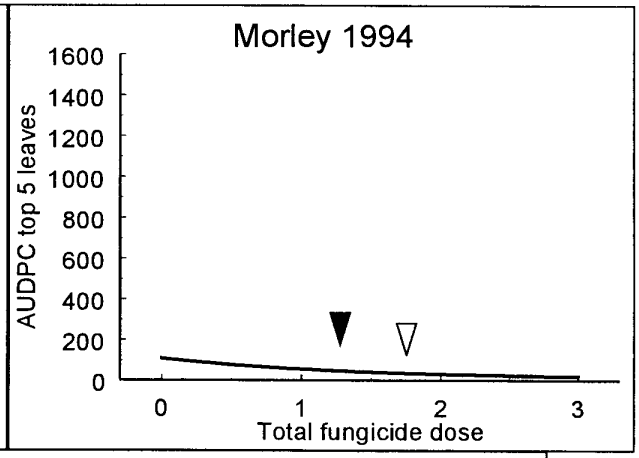
Table 4.15
Total fungicide dose v AUDPC for leaf 2 1996

NB different y-axis scales

Arrows indicate optimum total fungicide dose for yield as determined by surface response analysis (open triangles) and exponential curves (solid triangles)







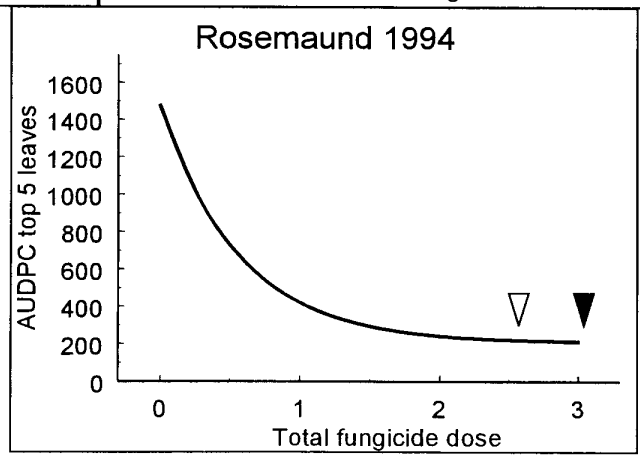


Table 4.16.
Total fungicide dose v AUDPC for top 5 leaves 1994

Arrows indicate optimum total fungicide doses for yield as determined by surface response analysis (open triangles) and exponential curves (solid triangles)

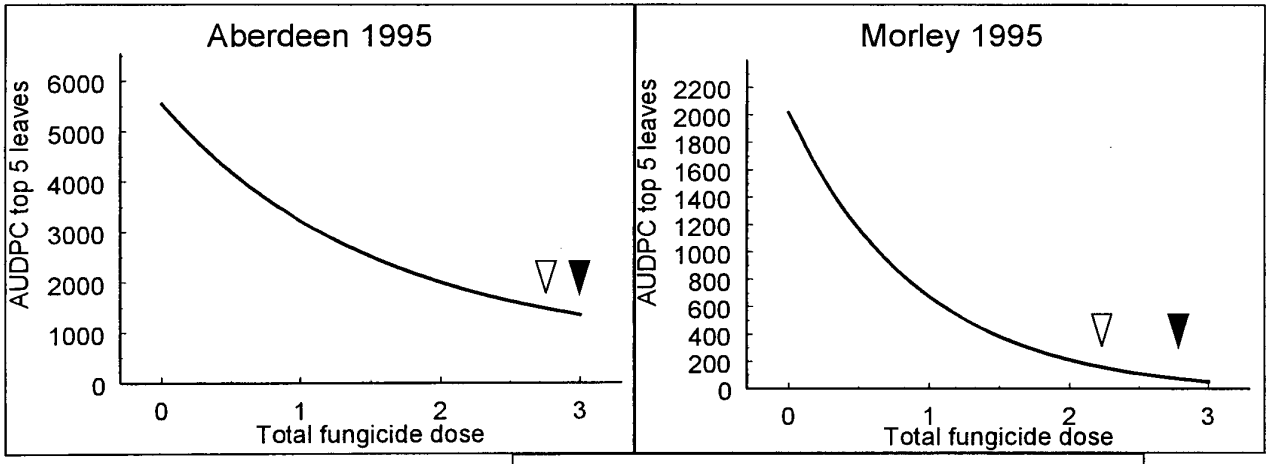
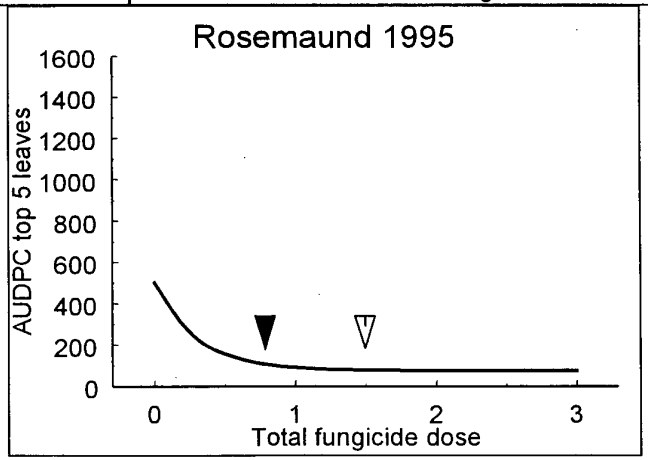


Table 4.17.
Total fungicide dose
v AUDPC for top 5 leaves
1995

NB different y-axis scales

Arrows indicate optimum total fungicide doses for yield as determined by surface response analysis (open triangles) and exponential curves (solid triangles)



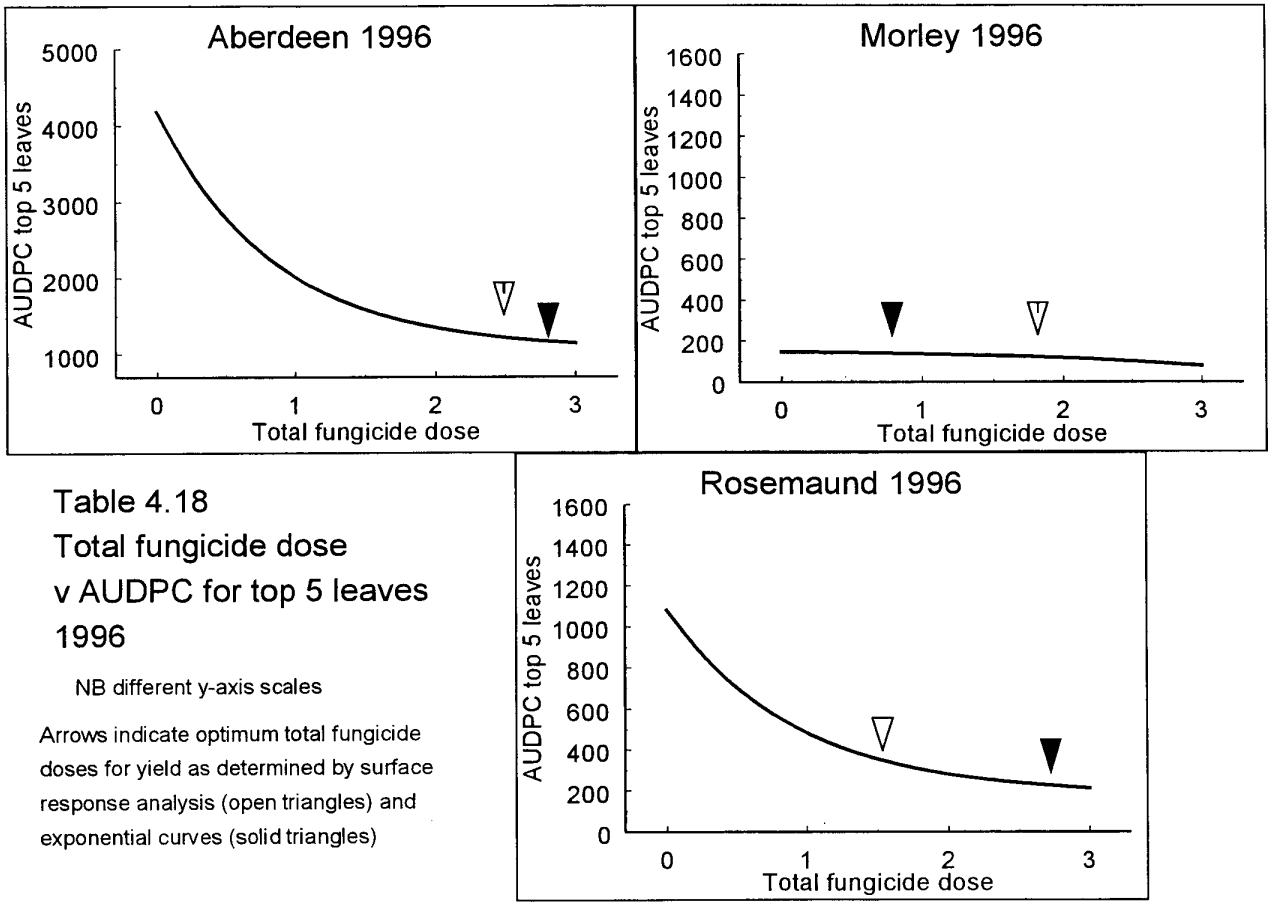


Table 4.18
Total fungicide dose
v AUDPC for top 5 leaves
1996

NB different y-axis scales

Arrows indicate optimum total fungicide doses for yield as determined by surface response analysis (open triangles) and exponential curves (solid triangles)

The optimum total fungicide doses for yield as determined by both exponential curve analysis and surface response analysis are indicated in all figures. They occur where the graphs are beginning to flatten out. Of the five sites with moderate to severe disease, at three sites the optima occurred where the AUDPC for the top 5 leaves was 200-400 (Morley 1995, Rosemaund 1994, 1996). At the other two sites (Aberdeen 1995, 1996) the optima were close to where the curves flattened out but at AUDPC's of 1200-1500. In very low disease sites (Morley 1994, 1996, Rosemaund 1995) the curves are relatively flat suggesting the optimum total fungicide dose for yield ought to be at a lower total fungicide dose than suggested by surface response analysis. The yield surfaces in these sites were very flat anyway.

4.5. Effect of timing and number of fungicide applications on disease

As with the effect of total fungicide dose on yield, taking the mean yields from the 39 treatments, comparisons can be made of the disease resulting from the same fungicide dose where it has been applied in 1, 2 or 3 applications. Table 4.8 gives the results of these comparisons for the five sites with moderate to severe disease levels.

Table 4.8. Mean AUDPC on leaf 2 resulting from applying one full fungicide dose in 1, 2 or 3 applications

	Average AUDPC on leaf 2 at a total fungicide dose of 1 Number of applications			UT AUDPC
Site	1	2	3	
Rosemaund 1994	121	85	31	330
Aberdeen 1995	1050	853	902	1564
Morley 1995	329	223	157	717
Aberdeen 1996	670	433	292	1251
Rosemaund 1996	66	48	31	199
Average	447	328	283	812

The number of values contributing to the means in Table 4.8 differ between 1,2 and 3 applications but represent all but one possible combination of doses to apply 1 full dose. It is clear that the control of disease is greatest where the same total fungicide dose is applied in multiple applications. In other words disease control is more efficient with frequent small dose applications. This is unsurprising in that all leaves throughout the critical growing period will have received some fungicide with three applications, but both two and three application programmes will have applied fungicide to leaf 2. In this instance, the additional application at GS 30 has enhanced disease control later in the season presumably by reducing inoculum.

The effect of fungicide timing on disease control can be examined in several ways. Taking the disease on the top 5 leaves (total AUDPC) determined from the 39 programmes in each trial, the average of single applications of 0.25, 0.5, 0.75 and full doses at the three timings can be determined. The lowest disease in the five trials with moderate to severe disease was recorded in each trial by single applications at GS 31/2 (Table 4.9). Fungicide at this timing would have some curative effect on disease established on leaves 4 and 5 and protective effect on leaf 3. It would

probably reduce disease on leaves 1 and 2 through a reduction in inoculum. Single fungicide applications at GS 30 resulted in disease levels lower or equal to that from single applications at GS 39/49. This suggests that this early application can effectively protect leaves 4 and 5 and reduce disease spreading to upper leaves. That single applications at GS 39/49 usually gave the poorest control of disease on the top 5 leaves is unsurprising. They would have little eradicative effect on disease established on leaves 4 and 5, some effect on disease on leaf 3 and only effectively protect the top 2 leaves.

The contribution of GS 30 applications to disease control can be ascertained also by plotting graphs of total fungicide dose against AUDPC for different doses at GS 30. An example of such a graph is shown in figure 4.19. In this example at Rosemaund in 1996, above a total fungicide dose of a half, the application of a GS 30 fungicide improved control of disease over that where no GS 30 fungicide was applied whatever the total fungicide dose. The maximum total fungicide dose possible without a GS 30 application is 2 full doses, additional fungicide through application at GS 30, usually improved disease control but at other sites by only a very small amount.

Table 4.9. Mean disease as AUDPC on top 5 leaves developing after single fungicide applications at each of three timings

	Average AUDPC to single fungicide applications at:			UT
Site	GS 30	GS 31/2	GS 39/49	AUDPC
Rosemaund 1994	693	531	850	1474
Aberdeen 1995	4425	3434	4645	5546
Morley 1995	1216	754	1556	2018
Aberdeen 1996	2868	2506	2828	4181
Rosemaund 1996	632	557	880	1083
Average	1967	1556	2152	2860

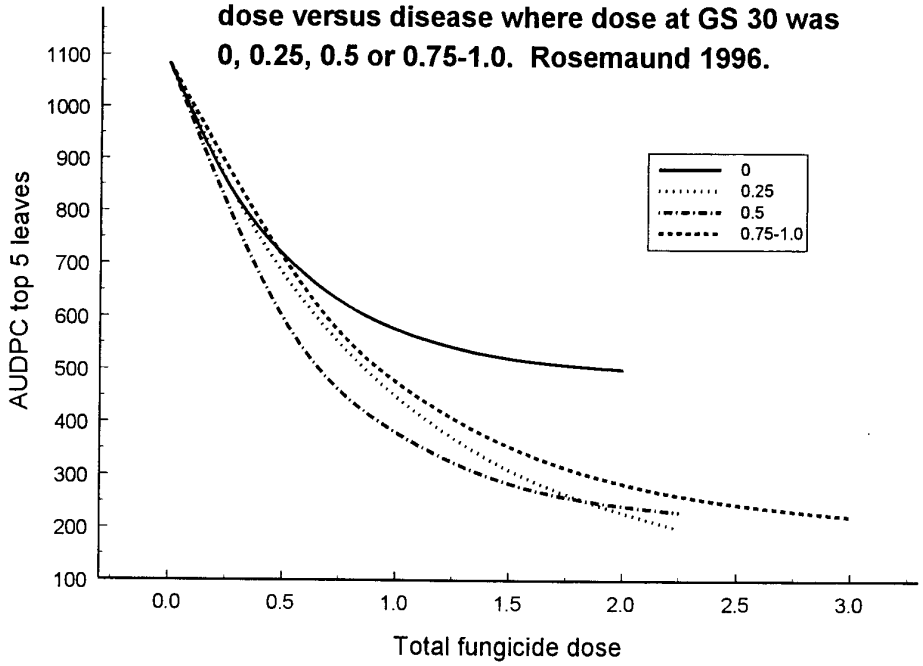
4.6. Effect of disease on yield

Using the adjusted means for each trial and the total AUDPC for the top 5 leaves, the disease/ yield loss relationships were ascertained using linear regression. The regression lines for all nine sites are shown in Figure 4.20 with their respective regression equations. Figure 4.21 shows the lines with data points for the five sites with moderate to severe disease. There is a good correlation between yield and total AUDPC for the top 5 leaves, with correlation coefficients between -0.66 and -0.95 (Appendix 4).

If the effect of disease on yield was uniform at all sites, the slopes of the regression lines would be parallel. It is clear, however, that they differ markedly from site to site. This might be explained by a different pattern of epidemic at different sites or by some factor that results in the crop being able to tolerate more disease without loss in yield. The sites with the most severe epidemics which persisted throughout, Aberdeen 1995 and 1996 had regression lines less steep that those sites with less severe epidemics. Thus it seems unlikely that the pattern of epidemic explains the differences.

Observations on the trials, however, indicated that, consistently, the Aberdeen site had a greater ear population than the other sites and, it is probable, a greater green leaf area also. If this was the case then they possibly had more green leaf area than required for optimum yield and consequently could tolerate some loss of green leaf without penalty.

Figure 4.19. Exponential curves of total fungicide dose versus disease where dose at GS 30 was 0, 0.25, 0.5 or 0.75-1.0. Rosemaund 1996.



Evidence that the Aberdeen site had a luxury production of green leaf is suggested by examining the seed rates for each site, each of which follow local practice. At Rosemaund the target population of seeds sown per square metre was 350. The target at Morley was 400 but at Aberdeen it was 500 seeds / m^2. These seed rates were used regardless of sowing date but there was no indication of a sowing date/ seed rate interaction. (The only effect of sowing date across the nine trials was that, taking the three full dose yields, the lowest two yielding sites were those sown in October).

Determination of optimum seed rate undoubtedly has been carried out by each collaborating organisation. It reflects the average number of seeds required to establish an optimum ear population under average conditions taking into account germination losses and losses due to winterkill etc. At Aberdeen, autumn conditions can be very difficult and the soil cools more rapidly than further south. With a greater potential for winterkill a relatively high seed rate is used. The three autumns of 1994, 1995 and 1996 were, however, some of the mildest on record and the crops established and tillered extremely well. Thus the impression of thick crops at this northern site seem substantiated. Crops with high ear populations are usually more prone to lodging but no lodging was recorded at Aberdeen or any other site in any year.

Fig. 4.20. Linear regression of yield v total AUDPC on top fives leaves at 9 sites. 1994-1996

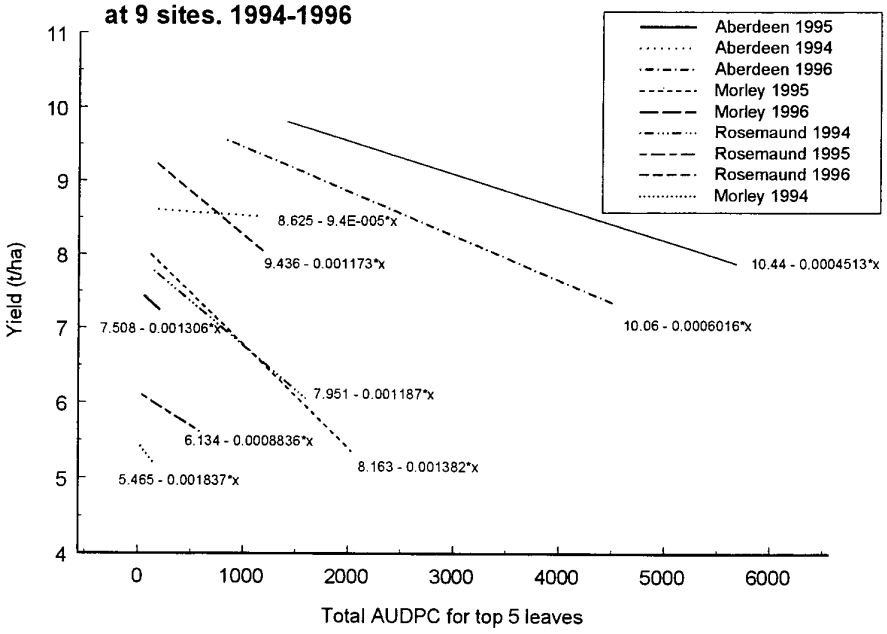
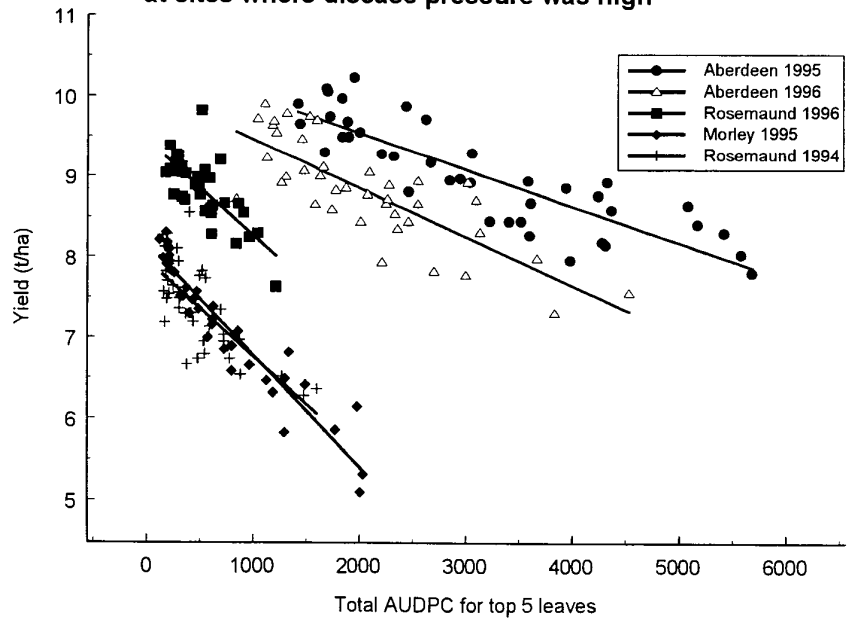


Fig. 4.21. Linear regression of yield v AUDPC on top five leaves at sites where disease pressure was high



The fact that the disease/ yield loss relationship differed from site to site creates difficulty for those trying to judge the most appropriate dose for a particular situation. The suggestion that crops with a green area index (GAI) above a certain optimum are more tolerant of disease (a situation already identified in wheat in MAFF/HGCA IDR trials) suggests that the optimum GAI for barley needs also to be determined if appropriate doses are to correctly determined. It has been the situation that Scotland has used very reduced fungicide doses to good effect, a situation that advisors in England and Wales have not been able to fully replicate. It is possible that very reduced fungicide doses have worked well in Scotland because of a generally higher seed rate and subsequently greater GAI and more tolerance by thicker crops to disease.

4.7. Effect of disease on grain quality

As expected, the reduction in specific weight and thousand grain weight between the highest and lowest disease level at low disease sites was minimal. At sites with moderate to high disease greater differences exist. In order to evaluate the effect of disease on grain quality, linear regression lines have been fitted to each set of data. These are shown in Figs. 4.22 to 4.24 for thousand grain weight and Figs. 4.25 to 4.27 for specific weight.

From the regression equations the loss in quality for a unit of disease can be determined. Table 4.10 below gives the loss in quality for each 200 AUDPC units for the five sites with moderate to severe disease. The low disease incidence at the other sites makes the unit loss estimate unreliable.

Table 4.10. Decrease in specific weight and thousand grain weight for increase in disease by 200 AUDPC units

Site	Decrease in quality for each increase in 200 AUDPC	
	Specific weight - kg/hl	Thousand grain weight - g
Rosemaund 1994	-0.48	-
Aberdeen 1995	-0.05	-0.15
Morley 1995	-0.51	-0.79
Aberdeen 1996	-0.12	-0.29
Rosemaund 1996	-0.36	-0.34

Losses in specific weight and thousand grain weight vary from site to site. It is interesting that the two Aberdeen trials where the most disease occurred have the smallest specific weight reductions. However, because the severity of disease at these sites were so high, the loss in thousand grain weight and specific weight was greater than these figures suggest. The relative reductions in specific weight and thousand grain weight for these five trials broadly relate to the relative slopes of the disease/yield loss regression equations. The greatest losses were experienced at Morley 1995 where a severe infection of brown rust occurred. Unlike other foliar diseases, brown rust attacks the ear and can cause substantially greater loss in yield and quality.

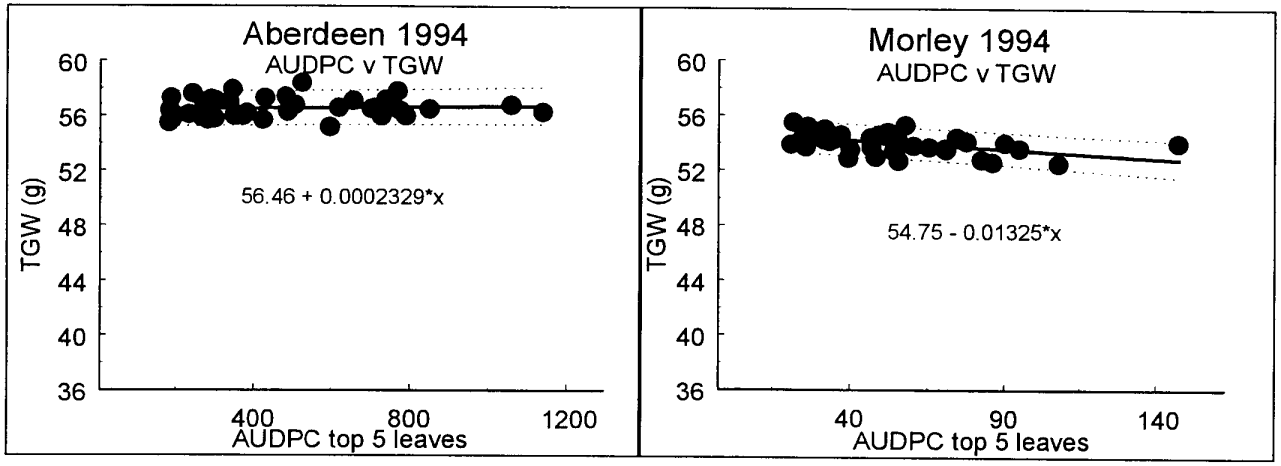


Fig. 4.22. Linear regression of thousand grain weight with AUDPC for top 5 leaves 1994
Dotted lines are 90% confidence intervals

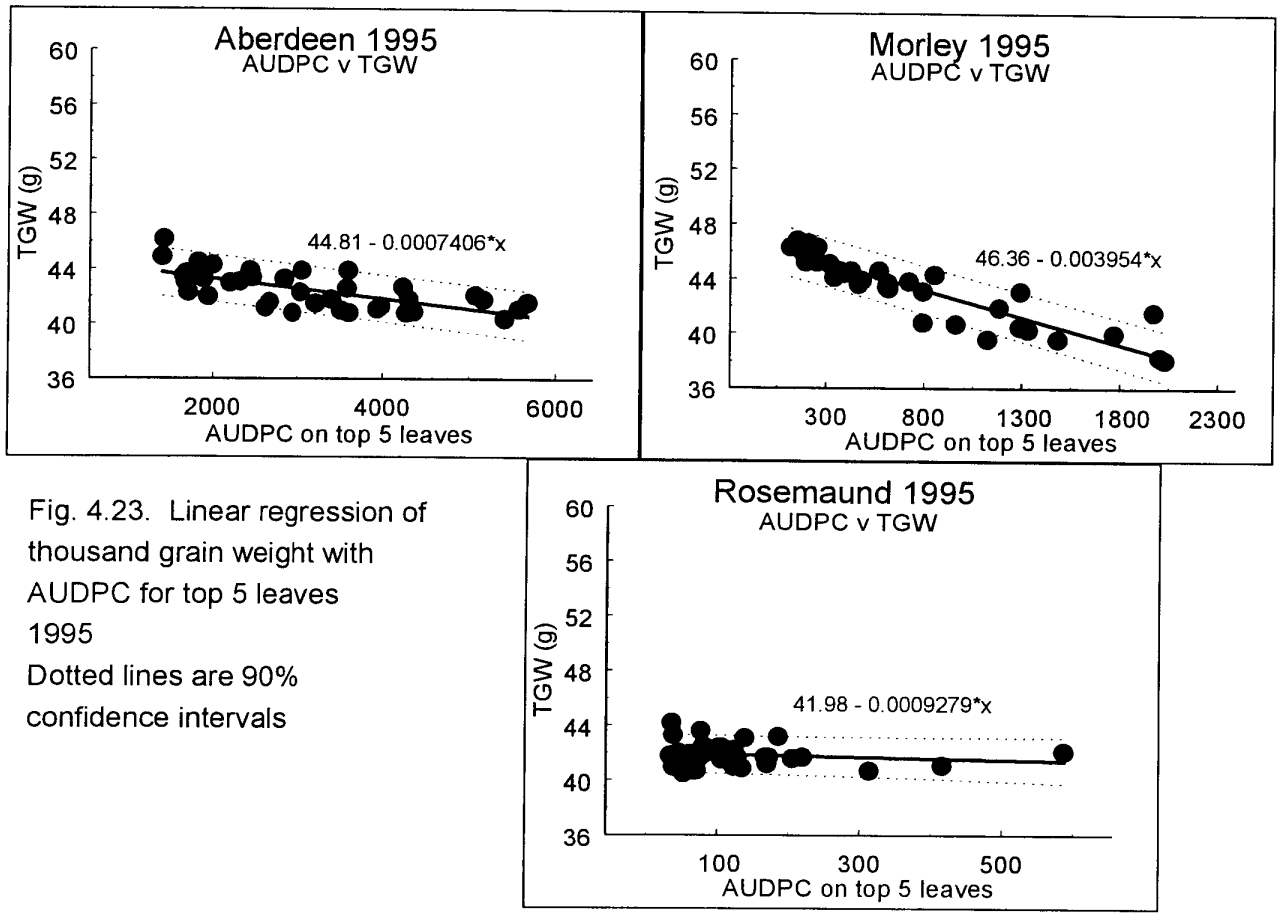


Fig. 4.23. Linear regression of thousand grain weight with AUDPC for top 5 leaves 1995
Dotted lines are 90% confidence intervals

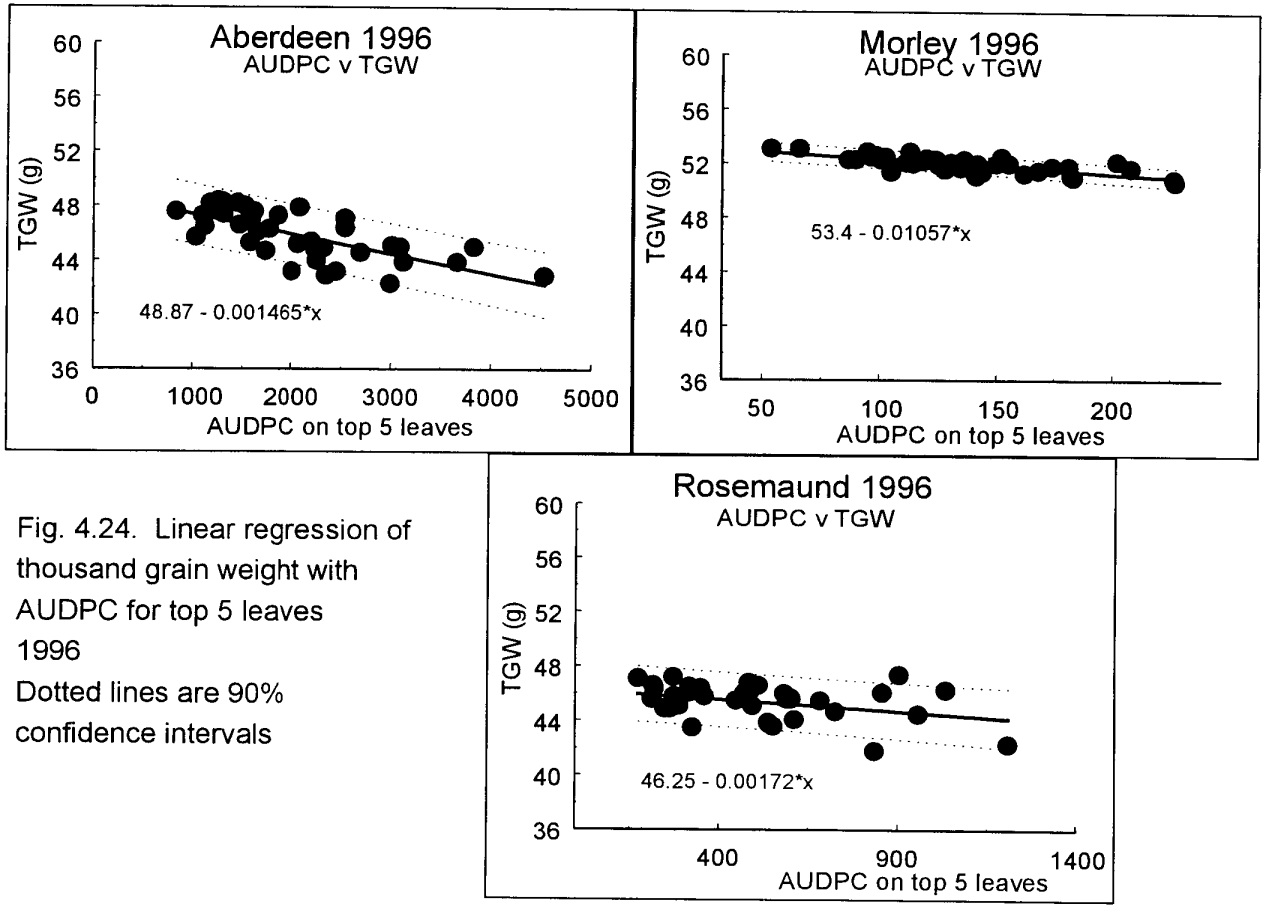


Fig. 4.24. Linear regression of thousand grain weight with AUDPC for top 5 leaves 1996
Dotted lines are 90% confidence intervals

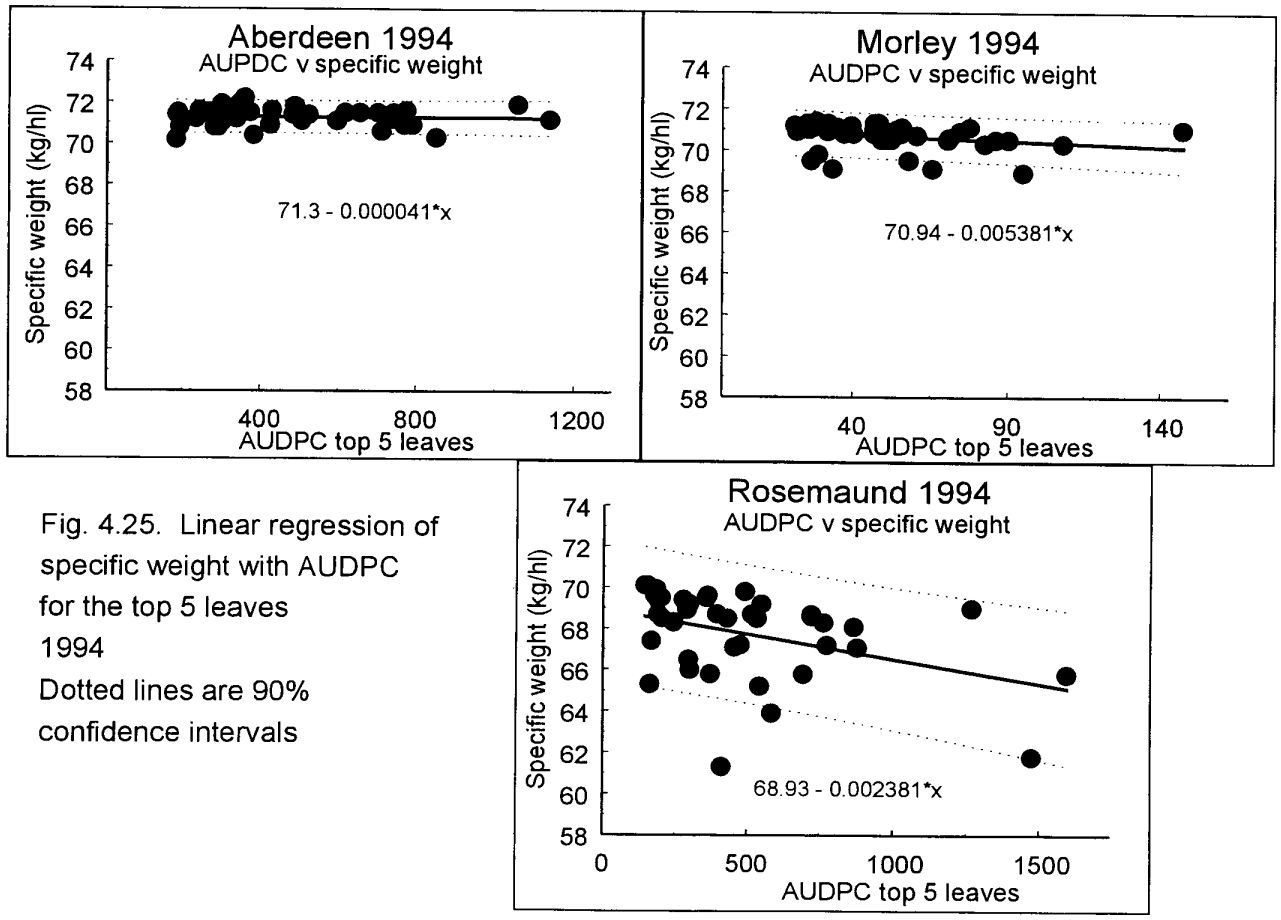


Fig. 4.25. Linear regression of specific weight with AUDPC for the top 5 leaves 1994
Dotted lines are 90% confidence intervals

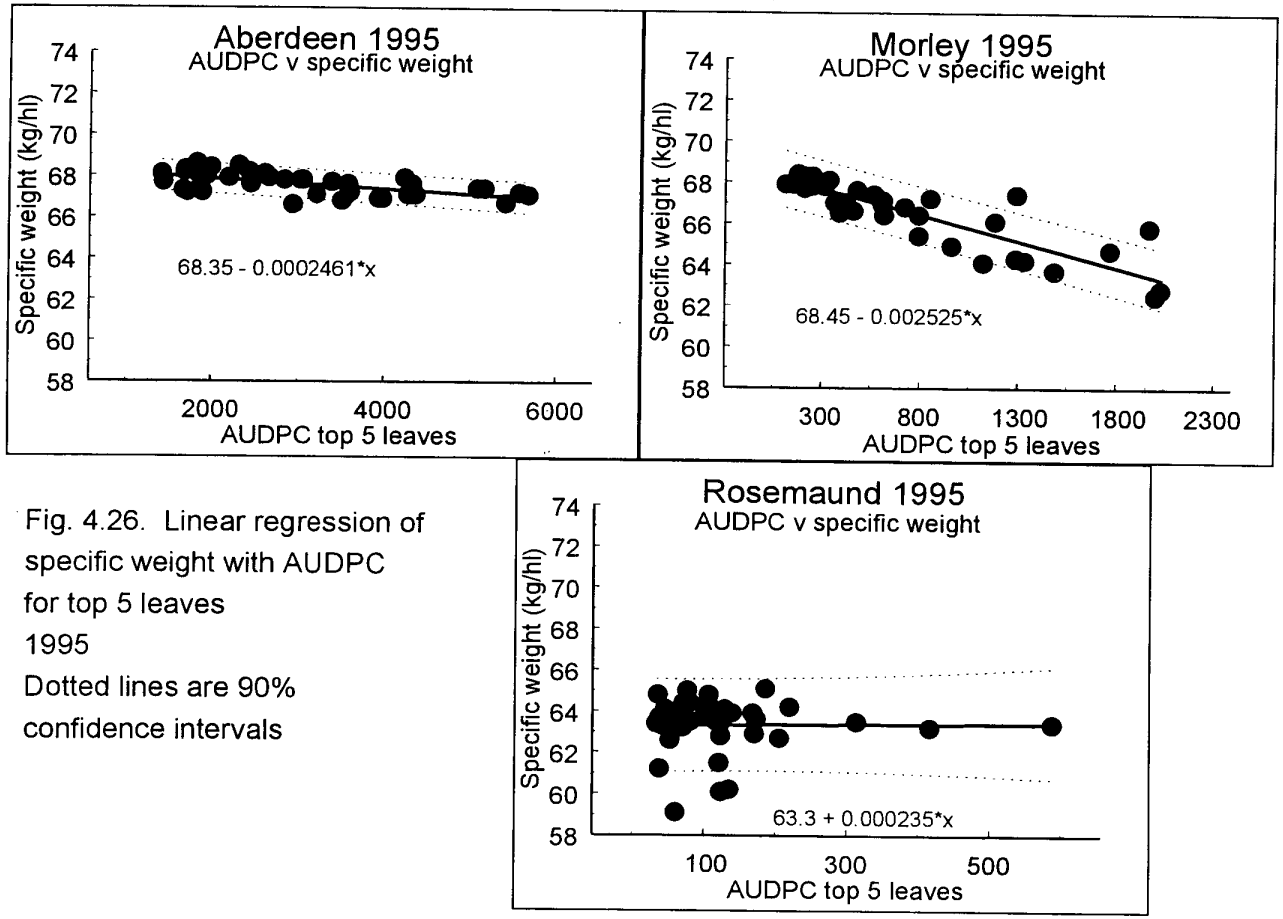


Fig. 4.26. Linear regression of specific weight with AUDPC for top 5 leaves
1995
Dotted lines are 90% confidence intervals

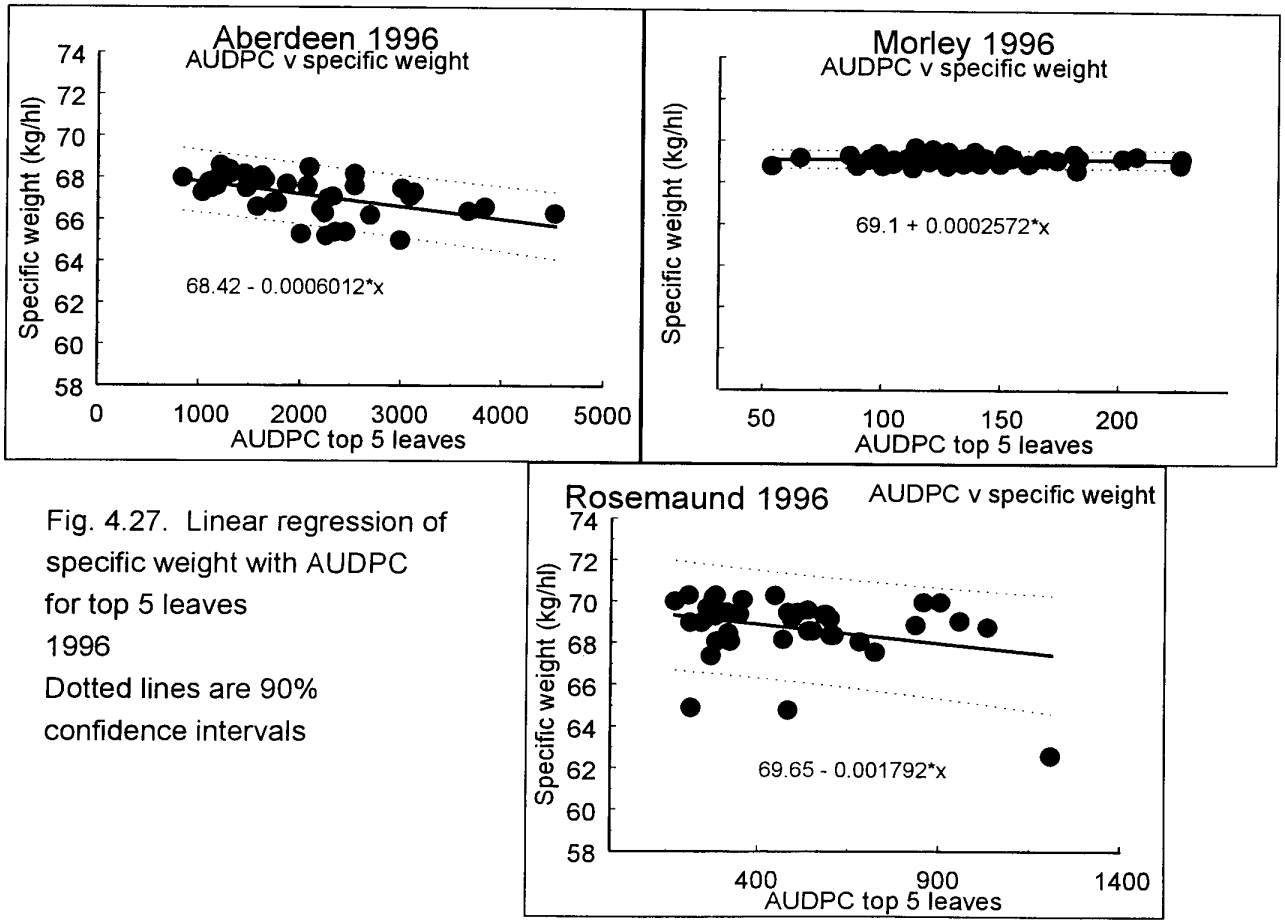


Fig. 4.27. Linear regression of specific weight with AUDPC for top 5 leaves 1996
Dotted lines are 90% confidence intervals

4.8. Profitability of fungicide programmes

In the following, profitability is expressed in terms of margin over cost. This is the value of the extra yield over the untreated less the cost of fungicide. For all calculations the cost of a full dose of Tilt + 3/4 Aura is £33.5. No account is taken of application costs. The inclusion of application costs is problematical as fungicides are often applied at the same time as other inputs and application costs should not just be associated with fungicides.

Utilising the exponential yield curves, margins over cost have been calculated at grain prices of £100/t and £80/t. These are shown in graphical form in Figs 4.28 to 4.30. The total fungicide dose for optimum profitability was always below the total fungicide dose for optimum yield.

At low disease sites, the optimum for profitability was always below a total fungicide dose of 0.5. The optima at different grain prices differed by no more than 0.13 total dose and are mostly much smaller than this (Table 4.11). It is obvious from the graphs that there is a distinct peak in the margin over cost curves at these low disease sites.

By contrast, at moderate to high disease sites, there is a much flatter profitability curve with a spread of 1 to 1.5 fungicide doses with a profit within £10 of the optimum. This suggests that there is a considerable leeway in total fungicide dose within which profitability is very similar. The optima at different grain prices at moderate to high disease sites were also similar, the maximum difference being 0.37 dose at Aberdeen 1995.

Table 4.11. Total fungicide dose for optimum margin over cost using exponential curve analysis

Site	Optimum total dose for profitability	
	£100/t	£80/t
Aberdeen 1994	0.39	0.26
Morley 1994	0.38	0.32
Rosemaund 1994	2.37	2.05
Aberdeen 1995	2.24	1.87
Morley 1995	2.28	2.07
Rosemaund 1995	0.27	0.27
Aberdeen 1996	1.43	1.35
Morley 1996	0.32	0.28
Rosemaund 1996	1.23	1.04

Using yields calculated by surface response analysis, the margin over cost for all combinations of fungicide dose and timing were computed. These are shown in Appendix 5 for grain at both £100/t and £80/t. The programme giving the optimum margin over cost for each trial can be ascertained from the tables in Appendix 5 but it is more pertinent to look at the range of programmes that fall within £10 of the optimum as with the exponential curves. The ranges are given in Table 4.12 together with the corresponding total fungicide doses. Whilst the total fungicide doses

determined for the range of programmes from surface response analysis mostly encompass the optimum total fungicide dose determined for exponential curves, there is one disparity. The total fungicide dose for Rosemaund 1994 estimated by exponential curve analysis, is considerably greater than the maximum of the range for surface response analysis.

Only in two out of nine trials did the optimum fungicide programmes for margin over cost, as determined by surface response analysis, include a GS 30 fungicide application. This would seem to contrast with earlier statements about effectiveness of GS 30 applications reducing disease. However, programmes at the upper end of the range for margin over cost (Table 4.12) which are within £10 of the optimum almost all include a GS 30 fungicide treatment.

It is clear from the range indicated that a number of programmes can achieve virtually the same profit. Whilst in surface response analysis the number of programmes that can achieve this appear to be restricted, especially at moderate to severe disease sites, the clear relationship between total fungicide dose and disease strongly supports the contention that the total fungicide dose is more important than timing, although timing clearly has some influence on profit. The AUDPC values achieved in the various treatments at the same fungicide dose are frequently similar, particularly where two or three applications are made.

Using surface response analysis, the optimum programmes that gives the greatest margin over cost at each site are almost the same for grain at £100/t and £80/t.

The optimum total fungicide dose determined by surface response analysis for margin over cost was always considerably less than that for yield except at Morley 1995 and Rosemaund 1996 where both the optimum programme for yield and margin over cost were the same.

Examining the range of programmes around the optimum for margin over cost, at all Morley and Rosemaund sites the total AUDPC for the top 5 leaves is always kept below 400 and usually in the range 200-400. The results for these sites suggest that maximum profit comes from preventing total disease rising above an AUDPC of around 200 but disease up to this level can be tolerated. At Aberdeen, where the disease/yield loss relationship was different, the AUDPC at optimum profit levels was 790 - 2200. Thus with these trials, three times the level of disease was tolerated than at other trials. This confirms the need to consider the physiological status of the crop when judging the appropriate fungicide dose.

An AUDPC of 200 or 400 is difficult to comprehend in practical terms. Figure 4.31 provides some guidance on the levels of visual disease during crop development that would give rise to an AUDPC of 245. This figure assumes a duration of leaves similar to that described in section 4.1. In essence, disease levels are constrained to 5% leaf area infection by the end of the life of leaves 4 and 5 and to 3 and 2% for leaves 2, 3 and 1 respectively.

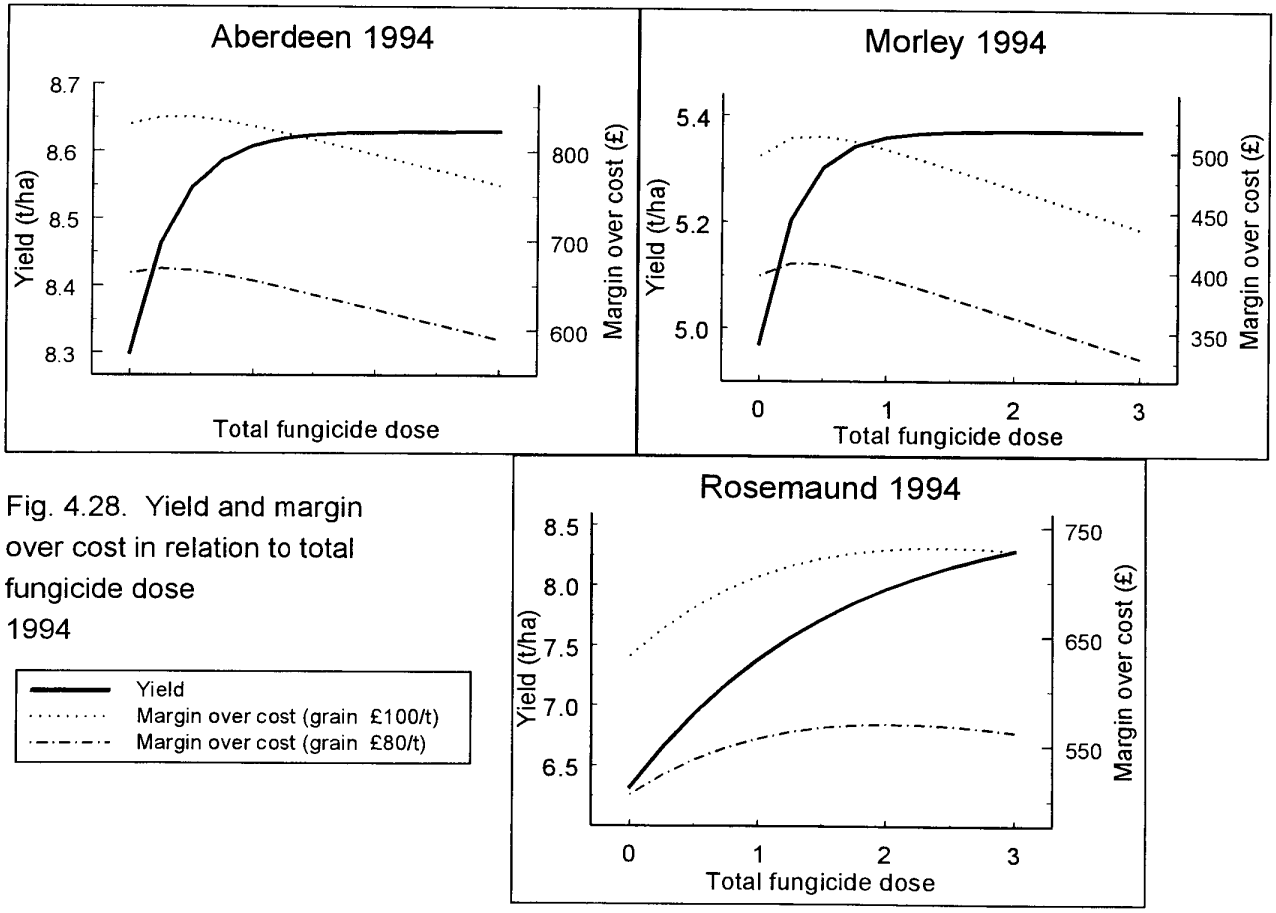


Fig. 4.28. Yield and margin over cost in relation to total fungicide dose
1994

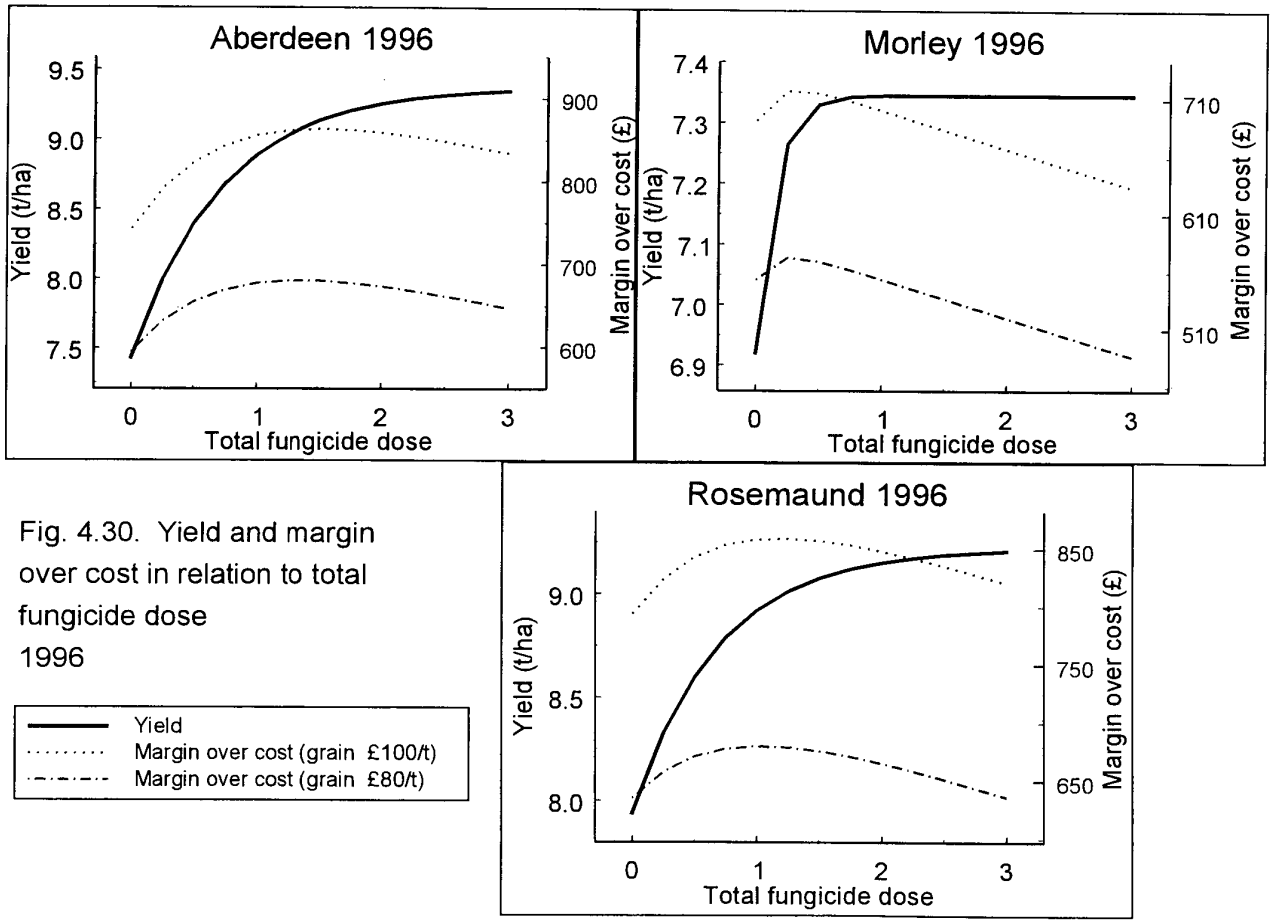


Fig. 4.30. Yield and margin over cost in relation to total fungicide dose
1996

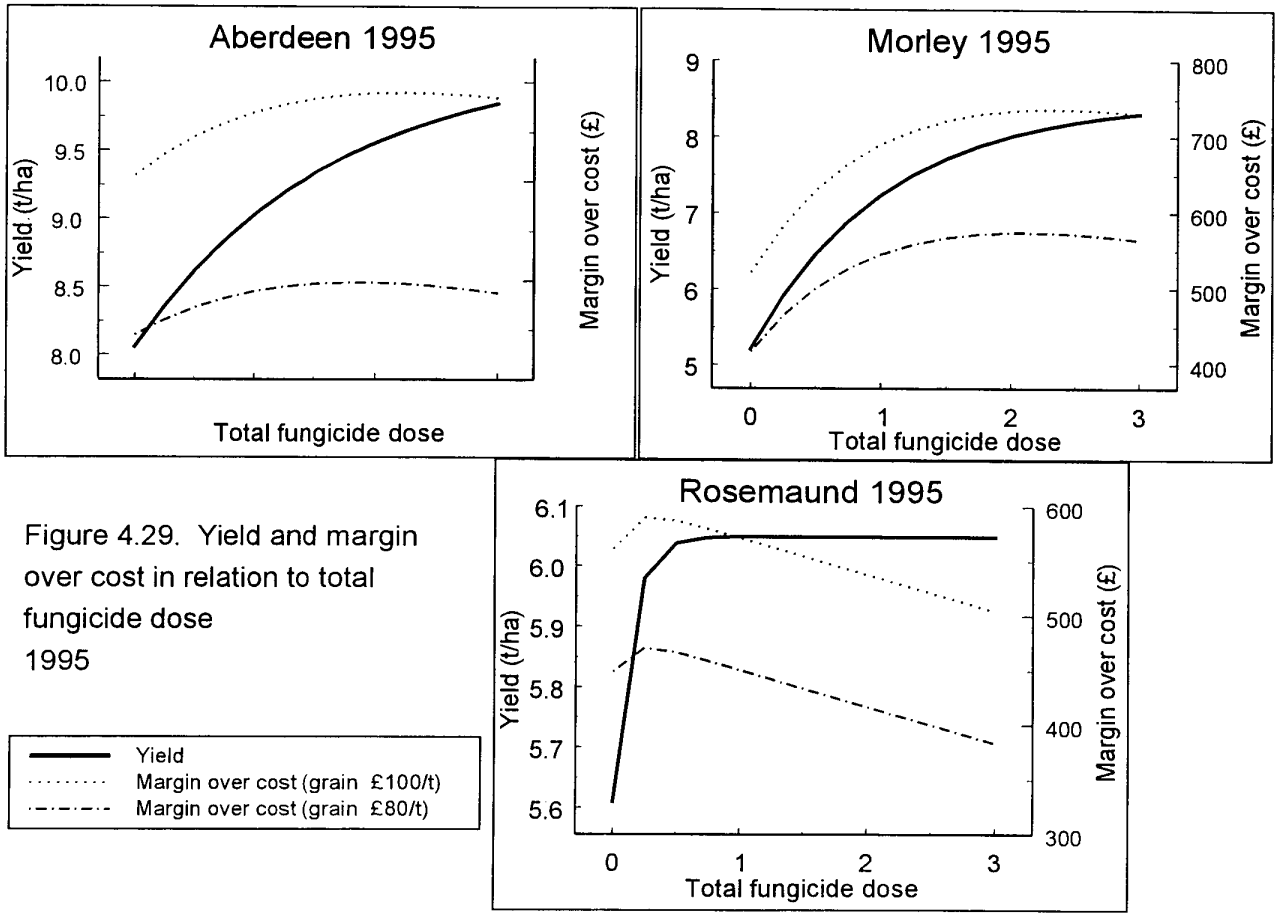
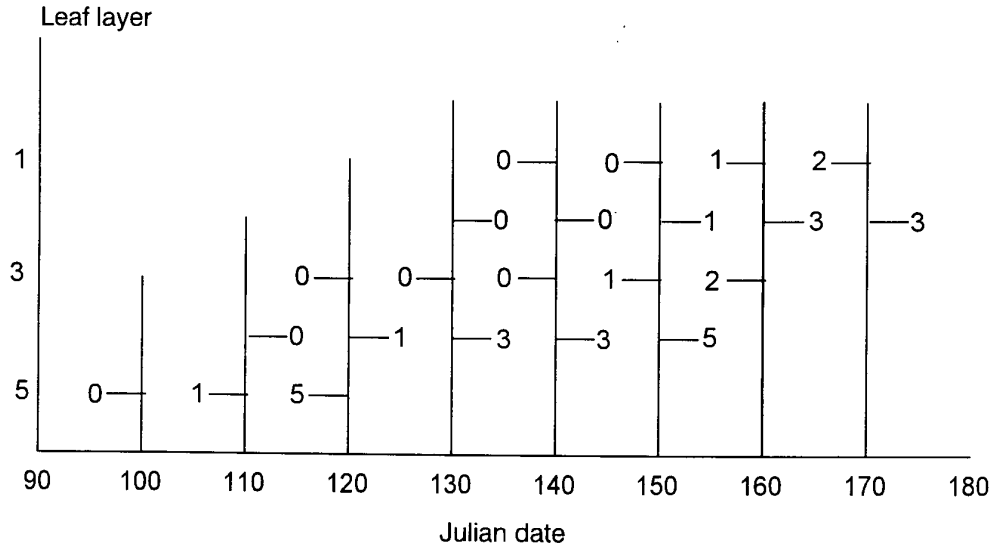


Figure 4.29. Yield and margin over cost in relation to total fungicide dose
1995

Table 4.12. Fungicide programmes and total fungicide dose giving optimum margin over cost and range within £10 of optimum determined by surface response analysis. Grain valued at £100/t

Site	Optimum margin over cost				Minimum of range of margin over cost				Maximum of range of margin over cost			
	GS 30	GS 31/2	GS 39/49	Total fungicide dose	GS 30	GS 31/2	GS 39/49	Total fungicide dose	GS 30	GS 31/2	GS 39/49	Total fungicide dose
Aberdeen 1994	0	0	0	0	0	0	0	0	0.5	0	0	0.5
Morley 1994	0	0	0	0	0	0	0	0	0.5 0.25 0.5	0 0.25 0.25	0.25 0.25 0	0.75 0.75 0.75
Rosemaund 1994	1	0	0.25	1.25	1	0	0.25	1.25	1	0	0.5	1.5
Aberdeen 1995	0	0.75	1	1.75	0	0.5	1	1.5	1	0.75	1	2.75
Morley 1995	0.75	0.75	0.75	2.25	0.5 0.75	0.5 0.5	0.75 0.5	1.75 1.75	0.75	0.75	0.75	2.25
Rosemaund 1995	0.25	0	0	0.25	0	0	0	0	0.5	0.5	0	1
Aberdeen 1996	0	1.0	0.75	1.75	0	1	0.5	1.5	0.25 0	1 1	0.75 1	2 2
Morley 1996	0	0.25	0.25	0.5	0	0	0	0	0.25 0.5	0.5 0.5	0.5 0.25	1.25 1.25
Rosemaund 1996	0	0.5	1	1.5	0	0.5	0.75	1.25	0	0.5	1	1.5

Figure 4.31. Example of disease progress that would result in an AUDPC of 245



Whatever method of analysis was undertaken, it is clear that there were large differences between the optimum total fungicide dose for profit and that for yield. Assuming this is generally the situation, care is required by growers that they recognise this fact and adjust fungicide inputs accordingly. However, it is often easier to apply more than required for 'insurance' as under application can lead to substantial loss in yield. What is required is greater confidence in how disease is likely to progress when decisions on fungicide applications are being made, the degree of control possible by fungicides and consequently the ultimate level of disease that will result from a fungicide application.

The IDR strategy discussed in the next section aims to help growers decide by how much disease would develop if it were left uncontrolled by fungicides. Experiments 1 and 2 of this report give clear guidance on the dose required from a wide range of fungicides to restrain disease. Guidance on how much disease must be restrained in order to achieve optimum profitability is given above. The effect of green leaf area index on sensitivity of a crop to disease-induced yield loss appears to be important and requires further investigation.

4.9. Integrated disease risk strategy

The concept of Integrated Disease Risk (IDR) Strategy was first developed by Paveley (1993). It is a quantitative system for determining appropriate fungicide doses. For each foliar disease, an equation is formulated which takes into account inoculum (as incidence or severity at the time of assessment), weather conditions, varietal disease resistance and crop sensitivity. The latter is a measure of the extent of disease induced yield loss if disease was allowed to develop. This in turn is related to growth stage. For each element of the equation, a score is determined from simple tables and substitution into the equation for each disease results in a total score. Total scores are then related to fungicide dose. The dose applied (using a broad-spectrum fungicide able to control all diseases is the greatest of those determined for each disease. A description of the prototype IDR for winter barley is given in Appendix 6, and the principles explained in Wale & Murray (1995).

The appropriate fungicide dose for each of the three timings was determined for one treatment (40) by the site manager of each trial. No training was given to the site managers. All they used to setermine the appropriate dose was the summary of the IDR programmes as given in Appendix 6. The provision of written guidance only was deliberate, for if a system such as this is to be successful it must be able to be understood and effective for people with a wide range of experience.

The prototype was only moderately successful, falling within the range of programmes for optimum margin over cost determined by surface response analysis in half of the trials (Aberdeen 1995, Rosemaund 1995, Morley 1996 and Rosemaund 1996). It was clear that at low disease sites, the system tended to over-estimate the fungicide requirement. Even at low disease levels the equations favoured some fungicide application and this situation requires revision.

IDR attempts to predict the likely extent of disease development before the next key fungicide timing. In graphical terms this is the height up the y-axis that disease develops in a dose-response curve. From dose response curves it is then possible to determine the dose required to prevent disease developing above an acceptable level.

At high disease sites, IDR failed to identify the optimum total fungicide dose for profitability at Morley 1995 and Aberdeen 1996. The predominant disease at Morley 1995 was brown rust and the prototype IDR failed to recognise the potential explosive nature of this disease and its effect on yield from late attacks. Whilst the need to treat at all three timings was triggered, the optimum dose at GS 39/49 was 0.5 below that for effective control late in the growth of the crop.

The over-estimation of fungicide at Aberdeen 1996 was due to the failure to recognise that the disease/yield loss relationship differed with a crop of a high green leaf area index. It is clear, as explained earlier, that a crop with a green area index above a certain threshold appears to tolerate a certain level of disease.

Refinement of the prototype IDR is needed. In the light of the data from this project some modifications are possible. In particular, the target range of AUDPC on the top 5 leaves for optimum profit (>200 - <400) provides a more concrete basis for determining dose thresholds for the IDR equations. The dose response curves in

Experiment 1 and the variety x dose interaction in Experiment 2 will also contribute to refinement of the IDR equations.

However, the variability in disease/yield loss relationships found between sites in this project indicate that the priority is to understand how green area index influences the potential for yield loss. Until this is done, refinement in other aspects of IDR will not be worthwhile.

The concept of IDR is a valuable one, setting down as it does for the first time a way of quantifying the process of decision making for appropriate fungicide doses that has formerly been left to 'experience'.

Another aspect of the project that will help with refinement of the IDR comes from the detailed assessments of disease made by participating organisations prior to fungicide application. These assessments comprised 50 tillers and provided accurate assessments of incidence and severity of the four main diseases. From this data the relationship between incidence and severity of disease on leaves can be established. The relationships are shown in Fig. 4.32. There is a paucity of data for high incidences of brown rust and net blotch but exponential fits to the data can be made.

Size of lesion or pustule influences the shape of the curve. Pustules of brown rust are small and the exponential curve is flat. One hundred percent incidence of disease results in only 2% leaf area infection at minimum. With mildew and net blotch, the exponential curves are very similar. One percent severity is achieved with 60% and 50% incidence respectively. Scatter around the exponential curve for Rhynchosporium is much greater than for other diseases, reflecting the variability of this pathogen. With this disease, 100% incidence is not achieved until about 13% leaf area infection.

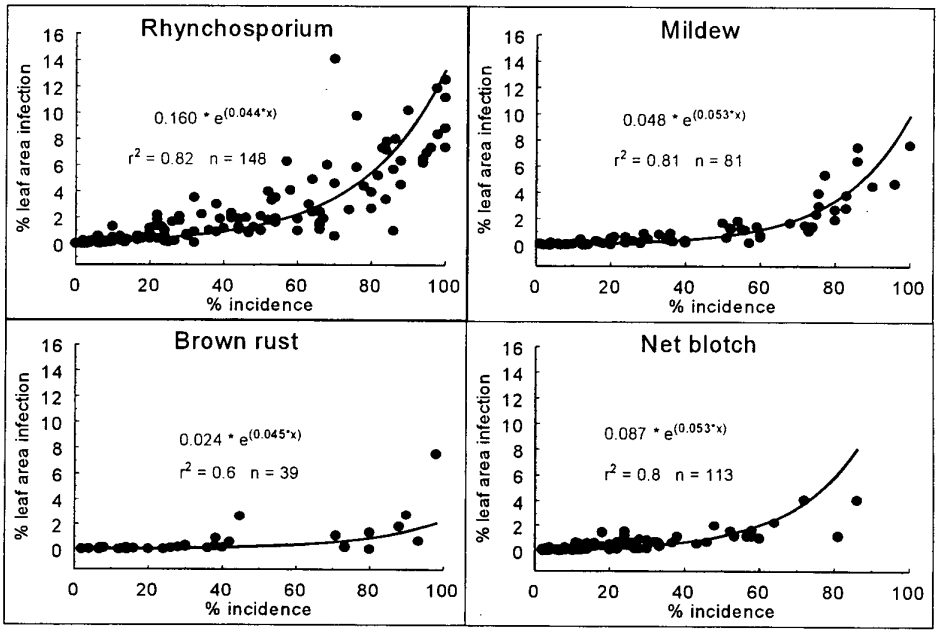
These relationships will be useful for ascertaining incidence thresholds (e.g. in spring barley disease control) and in refinement of the inoculum factor in IDR equations. In the prototype IDR, percentage incidence of a disease on a specific leaf layer is used to judge the level of inoculum. The data here can be used to refine incidence thresholds and will also permit them to be expressed in terms of mean percentage area infected.

Table 4.13. Fungicide programme and total fungicide dose for IDR treatments

Site	IDR treatment programme			
	GS 30	GS 31/2	GS 39/49	Total fungicide dose
Aberdeen 1994	0.25	0.5	0.75	1.5 ✖
Morley 1994	0	0.75	0.5	1.25 ✖
Rosemaund 1994	-	-	-	-
Aberdeen 1995	0.25	0.5	0.75	1.5 ✓
Morley 1995	0.25	0.75	0.25	1.25 ✖
Rosemaund 1995	0	0.75	0.25	1.0 ✓
Aberdeen 1996	1.0	1.0	0.75	2.75 ✖
Morley 1996	0	0.75	0.5	1.25 ✓
Rosemaund 1996	0.25	0.5	0.5	1.25 ✓

✓ falls within range of total fungicide doses for margin over cost determined by surface response analysis

Figure 4.32. Relationship of incidence to severity for four foliar diseases



5. CONCLUSIONS

This experiment was complex in design but using two different methods of data analysis, exponential curve analysis and surface response analysis, it has provided new pointers to disease control in winter barley. These pointers should assist crop managers with selection of appropriate fungicide doses.

5.1. Development of winter barley

* The top four leaves of winter barley persisted for approximately 6 weeks. Leaves 5 to 7 only persisted for about half this time.
* At GS 31 the uppermost fully expanded leaf was usually leaf 4
* At GS 32 the uppermost fully expanded leaf was usually leaf 3.

5.2. Total fungicide dose

* Most variation in yield (and by inference profit) was accounted for by the total fungicide dose. i.e. total of fungicide doses applied at each of three timings (GS 30, GS 31/2 and GS 39/49). The timing of fungicide application accounted for less variation in yield.
* This suggests that whilst timing is important, the total fungicide dose plays a bigger role in optimising yield and profit than when fungicide are applied
* Thus a number of fungicide programmes with the same total fungicide dose are able to give similar results.

5.3. Timing of fungicide application

* Applications at GS 31/2 consistently gave better disease control, yield increases and profit than applications at GS 30 or GS 39/49.
* Yield correlated most strongly with disease on leaves 2 and 3 and total disease on the top 5 leaves.
* Unlike wheat, where application around GS 39 to protect the top 2 or 3 leaves is the most important timing, in winter barley the most important timing at GS 31/2 will not protect leaf 2.
* Differences in physiology, as yet not fully understood, may account for differences in optimum timing between the winter cereals.
* Application at GS 30 was shown to be beneficial in disease control and yield response and sometimes profitability.
* GS 30 applications reduced inoculum and appeared to make subsequent applications more effective. This was particularly true where brown rust was present at GS 30 and severe later in the season and at sites where disease was severe early in the spring.
* At any particular total fungicide dose, three applications were more effective than two, and two more effective than one at reducing disease and increasing yield.

5.4. Optimum total fungicide dose for yield and profit

* In most instances the optimum total fungicide dose for profit was less (often considerably so) than that for yield.

* At low disease sites where the maximum yield response was 0.3 - 0.4 t/ha, the optimum total fungicide dose for yield varied from 0.5 to 1.25 but the optimum for profit was always below 0.5.
* Thus where disease is established at very low levels and the risk of disease development is low, very reduced rates are appropriate. However, growers are likely to apply some fungicide for insurance.
* At moderate to high disease sites where yield responses over 1 t/ha were recorded, there was a wide spread of total fungicide doses within £10 of the optimum margin over cost (profit) when determined by exponential curve analysis. Using surface response analysis, a more limited range of fungicide programmes were within £10 of the optimum margin over cost.

5.5. Effect of grain price on optimum total fungicide dose for profit

* Whichever method of analysis was used, the total fungicide dose for optimum profit hardly differed when the grain price reduced from £100/t to £80/t.

5.6. Disease/ yield loss relationship

* Across the nine trials a range of epidemics developed. Disease, as area under the disease progress curve (AUDPC), on individual upper leaves and total disease on the top 5 or 7 leaves were highly correlated with yield especially at moderate to high disease sites.
* Disease/ yield loss relationships differed markedly from site to site.
* Differences in disease/ yield loss relationships could not be related to the pattern of disease development. The most severe epidemics occurred at the Aberdeen site but the yield loss per unit of disease was the least.
* Observations indicated that in each year the Aberdeen site had the greatest ear populations and green leaf area indices. There may have been luxury production of leaf area and these crops were more tolerant of disease; that is able to lose a certain amount of green leaf area due to disease without consequent yield loss. Conversely sites with low green leaf area indices were damaged by disease to a much greater extent.
* Thus green leaf area index (GLAI) appears to be an important factor when judging the appropriate fungicide dose. This requires further investigation.
* Tolerance to disease of crops with high GLAI (which is common in crops north of the border) may explain why Scotland traditionally uses very low fungicide doses.

5.7. Disease control for optimum yield and optimum profit

* Using exponential curve analysis, the optimum yield was achieved where the curves flattened out (reached the lower asymptote).
* At the Morley and Rosemaund sites where GLAI was least, this occurred at AUDPC's for the top 5 leaves of 200 or less.
* At the Aberdeen site where GLAI was greatest, this occurred at AUDPC's of 400-1500.
* At the Morley and Rosemaund sites, the target AUDPC for the top 5 leaves for optimum profitability was in the range 200-400.
* At Aberdeen where the disease/ yield loss relationship was different and the crop was considered to have a greater GLAI, the AUDPC at optimum profit was 790-2200.

* This confirms that the physiological status of the crop needs to be considered when determining appropriate fungicide dose.

5.8. Effect of disease and total fungicide dose on grain quality

* Loss in thousand grain weight (TGW) and specific weight (SpWt) at low disease sites was minimal.
* At moderate to high disease sites, losses in TGW ranged from 0.15g/200 AUDPC units to 0.79g/200 AUDPC units.
* At moderate to high disease sites, losses in SpWt ranged from 0.05 kg/hl /200 AUDPC units to 0.51 kg/hl / 200 AUDPC units.
* At moderate to high disease sites, losses in TGW ranged from 0.72g/unit of fungicide to 2.76g/unit of fungicide.
* At moderate to high disease sites, losses in SpWt ranged from 0.37 kg/hl /unit of fungicide to 1.71 kg/hl /unit of fungicide.
* The greatest loss in grain quality occurred at Morley 1995 where a severe infection of brown rust occurred, probably because this disease has a potential to infect awns of barley.

5.9. Integrated disease risk (IDR) strategy

* Growers need to adjust their fungicide inputs according to the risk of disease-induced yield loss.
* To do this, a grower needs to know
    - how disease would progress if left unchecked
    - the control that would be achieved by different doses of different fungicides
    - the level of disease that is acceptable.

An integrated disease risk (IDR) strategy was developed in experiment 3 to help with the first of these, experiments 1 & 2 give guidance about the second and the results in experiment 3 give guidance about the third.
* The prototype described in this report was only moderately successful in identifying the total fungicide dose and programme of fungicides for optimum profit.
* The prototype IDR tended to over-estimate fungicide requirement at low disease sites and failed to take full account a severe late attack of brown rust.
* The IDR presented needs refinement but of greater priority is the need to understand how green leaf area index influences the potential for disease-induced yield loss.
* The relationship between incidence and severity for the four main foliar diseases of winter barley has been established.

5.10. Methods of yield analysis

* The two methods of analysis examined both have value in the analysis of yield and profit.
* The shape of exponential curves for yield reflect the disease pressure at the site. Low disease sites have a high value of k, moderate to high disease sites have a low value of k.
* The optimum total fungicide dose for yield determined by surface response analysis was consistently less than that determined by exponential curve analysis at moderate to high disease sites.

* The curves of exponential curve analysis are averages at each total fungicide dose and thus exponential curve analysis cannot identify the effect of timing. This is achieved by surface response analysis.
* Exponential curve analysis is probably better at identifying the optimum fungicide dose for yield at low disease sites.
* The optimum fungicide programme for yield determined by surface response analysis was usually distinct in moderate to high disease sites.
* Because of the flatter response in yield at low disease sites, the optimum total fungicide dose using surface response analysis was less clear than with exponential curve analysis.
* Surface response analysis usually accounted for a higher percentage of variation at moderate to high disease sites but accounted very little for variation at low disease sites.

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7. ACKNOWLEDGEMENTS

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APPENDICES

Appendix 1.
Actual and adjusted mean yields for each trial site

Table of treatments 1994

Treatment	GS 30 *	GS 31/2	GS 39/45
1	-	-	-
2	-	¼	-
3	-	½	-
4	-	¾	-
5	-	1	-
6	-		¼
7	-	-	½
8	-	-	¾
9	-	-	1
10	-	¼	¾
11	-	½	½
12	-	¾	¼
13	-	1	1
14	¼	-	-
15	¼	¾	-
16	¼	½	¼
17	¼	¼	½
18	¼	-	¾
19	¼	¼	¼
20	¼	1	1
21	½	-	-
22	½	½	-
23	½	¼	¼
24	½	-	½
25	½	½	½
26	½	1	¾
27	½	¾	1
28	¾	-	-
29	¾	¼	-
30	¾	-	¼
31	¾	1	½
32	¾	¾	¾
33	¾	½	1
34	1	-	-
35	1	1	¼
36	1	¾	½
37	1	½	¾
38	1	¼	1
39	1	1	1
40	Integrated Disease Risk Strategy (IDR)		

IDR treatments:

Aberdeen	¼	½	¾
Morley	0	¾	½
Rosemaund	-	-	-

1994

Treat	Aberdeen			Morley			Rosemaund		
	Actual	Adjusted	SE of adj	Actual	Adjusted	SE of adj	Actual	Adjusted	SE of adj
1	8.30	8.30	0.285	5.15	4.97	0.161	5.96	6.28	0.470
2	8.10	8.41	0.292	4.84	5.02	0.158	6.93	6.89	0.480
3	8.86	8.46	0.278	5.20	5.12	0.155	7.23	7.20	0.480
4	8.71	8.89	0.277	5.44	5.49	0.158	7.45	6.74	0.474
5	8.50	8.64	0.277	5.21	5.46	0.158	7.16	7.47	0.474
6	8.49	8.80	0.292	5.03	5.24	0.158	6.54	6.52	0.479
7	8.80	8.53	0.300	5.43	5.42	0.157	7.40	6.95	0.475
8	8.44	8.49	0.278	5.13	5.18	0.158	7.10	7.03	0.472
9	8.64	8.64	0.285	5.36	5.33	0.160	7.14	7.34	0.487
10	8.23	8.46	0.278	5.11	5.36	0.158	8.05	7.76	0.469
11	8.91	8.72	0.307	5.39	5.61	0.158	7.22	7.29	0.475
12	8.53	8.05	0.321	5.40	5.16	0.159	8.31	8.10	0.470
13	8.49	8.55	0.278	5.72	5.55	0.157	8.35	8.55	0.487
14	8.23	8.54	0.292	5.56	5.31	0.160	7.44	6.97	0.474
15	8.50	8.79	0.278	5.36	5.42	0.159	6.22	6.54	0.479
16	8.67	8.81	0.275	5.48	5.38	0.154	7.86	7.82	0.480
17	8.45	8.45	0.285	5.48	5.44	0.156	5.95	6.67	0.475
18	8.73	8.46	0.300	5.26	5.32	0.161	7.93	7.73	0.469
19	8.75	8.49	0.275	5.61	5.29	0.156	7.29	7.36	0.475
20	8.23	8.29	0.278	5.43	5.41	0.155	7.22	7.54	0.479
21	8.01	8.18	0.280	5.32	5.38	0.159	6.36	6.74	0.470
22	8.57	8.79	0.278	5.55	5.54	0.154	6.97	6.95	0.479
23	8.50	8.81	0.292	5.27	5.33	0.157	7.49	7.55	0.473
24	8.07	8.38	0.292	5.28	5.47	0.155	7.73	7.83	0.470
25	8.92	8.79	0.285	5.30	5.27	0.160	7.42	7.49	0.473
26	8.94	8.90	0.280	5.64	5.55	0.157	6.98	7.70	0.475
27	8.47	8.56	0.276	5.39	5.46	0.161	7.96	7.90	0.470
28	8.66	8.54	0.285	5.32	5.38	0.157	7.46	7.13	0.477
29	8.87	9.09	0.275	5.51	5.42	0.157	7.63	7.30	0.477
30	9.13	8.86	0.300	5.65	5.39	0.160	7.31	7.62	0.474
31	8.59	8.56	0.280	5.36	5.18	0.157	7.59	7.57	0.479
32	7.78	7.95	0.280	5.37	5.60	0.155	7.94	7.48	0.475
33	8.71	8.54	0.278	5.65	5.64	0.157	8.08	8.28	0.487
34	8.42	8.09	0.285	5.55	5.46	0.157	7.26	6.80	0.474
35	8.15	8.24	0.276	5.60	5.48	0.158	8.65	7.94	0.474
36	9.11	9.12	0.285	5.24	5.35	0.155	6.87	7.19	0.479
37	9.31	8.96	0.275	5.25	5.33	0.154	7.44	7.64	0.487
38	8.58	8.55	0.280	5.28	5.45	0.158	8.58	8.13	0.471
39	8.67	8.64	0.280	4.98	5.19	0.154	7.54	8.27	0.471
40	9.06	8.86	0.263	5.47	5.35	0.130	6.69	6.36	0.383

Table of treatments 1995

Treatment	GS 30 *	GS 31/2	GS 39/45
1	-	-	-
2	-	-	-
3	-	¼	-
4	-	½	-
5	-	¾	-
6	-	1	-
7	-	-	¼
8	-	-	½
9	-	-	¾
10	-	-	1
11	-	¼	¾
12	-	½	½
13	-	¾	¼
14	-	1	1
15	¼	-	-
16	¼	¾	-
17	¼	½	¼
18	¼	¼	½
19	¼	-	¾
20	¼	¾	½
21	¼	½	¾
22	¼	1	1
23	½	-	-
24	½	½	-
25	½	-	½
26	½	½	½
27	½	¾	¾
28	½	1	¾
29	½	¾	1
30	¾	-	-
31	¾	¼	-
32	¾	-	¼
33	¾	1	½
34	¾	½	1
35	1	-	-
36	1	1	¼
37	1	¼	1
38	1	½	½
39	1	1	1
40	Integrated Disease Risk Strategy (IDR)		

At the Morley site a treatment 41 was included.
This was treated as 40, but a Tilt + ¾ Sanction mix was applied instead of Tilt + ¾ Aura

IDR treatments:

Aberdeen	¼	½	¾
Morley	¼	¾	¼
Rosemaund	0	¾	½

1995

Treat	Aberdeen			Morley			Rosemaund		
	Actual	Adjusted	SE of adj	Actual	Adjusted	SE of adj	Actual	Adjusted	SE of adj
1	8.2	7.81	0.336	5.15	5.31	0.131	5.18	5.60	0.269
2	7.8	8.31	0.338	5.13	5.10	0.133	5.65	5.61	0.273
3	9.3	8.94	0.478	6.63	6.58	0.132	6.38	6.27	0.269
4	8.6	8.44	0.342	6.88	6.89	0.132	6.15	5.93	0.266
5	9.5	9.29	0.335	6.97	7.08	0.13	6.14	6.57	0.272
6	9.2	8.95	0.341	7.15	7.00	0.138	6.59	6.29	0.267
7	8.2	8.03	0.342	5.89	5.86	0.13	6.02	5.82	0.278
8	7.9	8.41	0.333	6.05	6.15	0.13	5.63	5.80	0.269
9	8.6	8.76	0.327	6.51	6.49	0.136	6.17	6.08	0.269
10	8.3	8.27	0.332	6.20	6.32	0.132	5.48	5.91	0.272
11	8.4	8.93	0.338	7.39	7.35	0.132	5.87	5.83	0.273
12	10.3	10.23	0.331	7.59	7.52	0.13	6.17	6.07	0.269
13	9.5	9.17	0.331	7.24	7.30	0.129	6.08	5.87	0.278
14	10.2	9.97	0.341	7.80	7.80	0.131	5.88	6.08	0.267
15	8.1	8.19	0.334	5.97	5.83	0.138	6.09	5.83	0.266
16	8.5	8.45	0.334	7.44	7.47	0.13	6.42	6.34	0.272
17	9	8.81	0.341	7.61	7.51	0.131	6.63	6.53	0.269
18	8.8	8.68	0.337	7.52	7.57	0.13	5.92	5.84	0.272
19	8.2	8.44	0.335	7.05	7.16	0.13	6.23	6.38	0.266
20	9.3	9.29	0.333	7.71	7.81	0.13	6.22	6.27	0.269
21	9.2	9.49	0.330	7.77	7.84	0.13	5.79	5.88	0.272
22	10.5	10.09	0.333	8.18	8.13	0.13	5.67	5.71	0.27
23	8.2	8.59	0.330	6.54	6.41	0.131	6.62	6.41	0.278
24	9	8.97	0.333	7.40	7.38	0.136	5.60	6.03	0.272
25	9.4	8.95	0.336	7.25	7.23	0.136	5.75	6.17	0.269
26	9.5	9.74	0.335	8.11	8.02	0.134	6.18	6.11	0.272
27	9.7	9.54	0.342	8.05	8.10	0.131	6.64	6.19	0.269
28	9.4	9.90	0.333	8.15	8.13	0.13	6.59	6.38	0.27
29	10.2	10.05	0.335	7.99	8.22	0.129	5.98	6.08	0.272
30	8.6	8.64	0.329	6.50	6.47	0.133	5.73	5.77	0.27
31	9	8.86	0.330	7.01	6.86	0.138	5.89	5.98	0.272
32	8.2	8.15	0.334	6.87	6.82	0.132	5.94	5.92	0.266
33	9.7	9.28	0.333	8.16	8.09	0.13	5.91	6.16	0.266
34	9.2	9.68	0.338	8.24	8.18	0.132	6.33	6.28	0.273
35	8	7.96	0.476	6.66	6.66	0.13	5.99	6.05	0.269
36	9.4	9.49	0.334	8.01	7.91	0.134	5.87	5.41	0.269
37	9.8	9.71	0.337	7.83	7.99	0.131	5.92	5.71	0.278
38	10.1	9.87	0.341	7.82	7.94	0.132	6.03	5.83	0.27
39	9.7	9.65	0.332	8.26	8.31	0.13	5.76	6.00	0.266
40	9	9.25	0.270	7.60	7.62	0.107	5.80	5.96	0.217
41				7.90*	7.88*	0.11*			

* Sanction + 3/4 Aura used instead of Tilt + 3/4 Aura

Table of treatments 1996

Treatments	GS 30 *	GS 31/2	GS 39/45
1	-	-	-
2	-	-	-
3	-	¼	-
4	-	½	-
5	-	¾	-
6	-	1	-
7	-	-	¼
8	-	-	½
9	-	-	¾
10	-	-	1
11	-	¼	¾
12	-	½	½
13	-	¾	¼
14	-	1	1
15	¼	-	-
16	¼	¾	-
17	¼	½	¼
18	¼	¼	½
19	¼	-	¾
20	¼	¾	½
21	¼	½	¾
22	¼	1	1
23	½	-	-
24	½	½	-
25	½	-	½
26	½	½	½
27	½	¾	¾
28	½	1	¾
29	½	¾	1
30	¾	-	-
31	¾	¼	-
32	¾	-	¼
33	¾	1	½
34	¾	½	1
35	1	-	-
36	1	1	¼
37	1	¼	1
38	1	½	½
39	1	1	1
40	Integrated Disease Risk Strategy (IDR)		

At the Morley site an additional four treatments were included. These were:

41	0	½	¾
42	0	¾	½
43	0	1	¾
44	0	¾	1

IDR treatments:

Aberdeen	1	1	¾
Morley	0	¾	½
Rosemaund	¼	½	½

1996

Treat	Aberdeen			Morley			Rosemaund		
	Actual	Adjusted	SE of adj	Actual	Adjusted	SE of adj	Actual	Adjusted	SE of adj
1	7.45	7.30	0.242	7.16	7.09	0.168	8.14	8.242	0.166
2	7.70	7.56	0.242	6.69	6.74	0.166	7.68	7.632	0.166
3	8.00	7.82	0.244	7.53	7.56	0.168	8.49	8.642	0.165
4	8.60	8.92	0.250	7.55	7.71	0.175	8.69	8.568	0.166
5	9.20	8.77	0.240	7.39	7.31	0.163	8.97	8.977	0.166
6	8.35	8.66	0.240	6.90	6.94	0.165	8.86	8.774	0.168
7	8.00	8.30	0.241	7.02	7.07	0.168	8.17	8.301	0.165
8	8.75	8.70	0.246	7.26	7.11	0.168	8.61	8.665	0.167
9	8.85	8.94	0.249	7.37	7.28	0.164	8.37	8.553	0.171
10	8.95	8.66	0.242	7.26	7.27	0.170	8.77	8.669	0.164
11	9.15	9.05	0.242	7.36	7.42	0.168	9.03	9.208	0.171
12	9.20	9.07	0.244	7.22	7.38	0.175	9.26	9.036	0.169
13	8.80	8.65	0.241	7.17	6.79	0.167	8.97	8.991	0.164
14	9.55	9.70	0.246	7.35	7.50	0.164	9.96	9.824	0.168
15	7.65	7.98	0.250	7.12	7.18	0.173	8.21	8.167	0.166
16	8.35	8.44	0.249	7.36	7.47	0.167	8.53	8.708	0.171
17	8.95	9.11	0.240	7.61	7.24	0.167	9.12	8.896	0.169
18	8.65	8.59	0.246	7.12	7.28	0.167	8.89	8.88	0.165
19	8.90	8.89	0.246	7.44	7.46	0.170	8.49	8.601	0.166
20	9.45	9.46	0.243	7.38	7.42	0.181	9.26	9.119	0.168
21	9.30	8.99	0.245	7.97	7.84	0.169	9.19	9.109	0.168
22	9.85	9.63	0.244	7.27	7.41	0.162	9.32	9.382	0.164
23	7.45	7.77	0.250	7.11	7.17	0.173	8.23	8.285	0.167
24	8.70	8.71	0.242	7.46	7.50	0.181	9.15	9.247	0.166
25	9.15	9.00	0.242	7.33	7.16	0.169	9.09	8.954	0.168
26	9.10	8.83	0.242	7.66	7.52	0.165	8.96	8.776	0.164
27	8.75	8.92	0.246	7.35	7.49	0.162	9.08	9.268	0.171
28	9.60	9.69	0.249	7.43	7.49	0.174	9.16	9.038	0.166
29	9.90	9.90	0.242	7.73	7.55	0.169	9.24	9.247	0.166
30	8.25	8.44	0.246	7.49	7.34	0.164	9.15	9.069	0.168
31	8.05	7.93	0.244	7.12	7.31	0.170	8.65	8.745	0.165
32	8.50	8.53	0.243	7.30	7.34	0.169	8.49	8.545	0.167
33	9.70	9.78	0.249	7.75	7.58	0.166	9.32	9.239	0.164
34	9.20	9.22	0.243	7.20	7.30	0.170	9.15	9.068	0.164
35	8.35	8.35	0.242	7.46	7.62	0.165	8.47	8.576	0.166
36	9.40	9.74	0.250	7.29	7.35	0.174	9.29	9.066	0.169
37	9.05	8.72	0.245	7.40	7.21	0.166	9.00	9.088	0.166
38	9.45	9.72	0.240	7.26	7.29	0.176	8.96	9.058	0.166
39	9.45	9.54	0.243	7.89	7.99	0.167	9.04	9.086	0.164
40	9.10	8.85	0.196	7.08	7.28	0.165	8.98	9.05	0.134
41				7.54	7.32	0.169			
42				7.02	7.06	0.176			
43				7.14	7.01	0.167			
44				7.13	7.29	0.172			

Appendix 2
Estimated yields from Surface Response Analysis
1994

Aberdeen 1994							Morley 1994							Rosemaund 1994						
		GS30							GS30							GS30				
GS31/2	GS39/49	0	0.25	0.5	0.75	1	GS31/2	GS39/49	0	0.25	0.5	0.75	1	GS31/2	GS39/49	0	0.25	0.5	0.75	1
0	0	8.55	8.59	8.62	8.62	8.62	0	0	5.22	5.3	5.33	5.33	5.29	0	0	7.35	7.38	7.5	7.71	8.01
	0.25	8.46	8.5	8.52	8.53	8.52		0.25	5.28	5.35	5.38	5.38	5.34		0.25	7.59	7.62	7.74	7.95	8.25
	0.5	8.43	8.46	8.49	8.49	8.49		0.5	5.3	5.37	5.4	5.4	5.36		0.5	7.67	7.7	7.82	8.03	8.33
	0.75	8.45	8.49	8.51	8.52	8.51		0.75	5.28	5.36	5.39	5.39	5.35		0.75	7.59	7.62	7.74	7.95	8.25
	1	8.53	8.57	8.59	8.6	8.59		1	5.24	5.31	5.35	5.35	5.31		1	7.35	7.38	7.5	7.71	8.01
0.25	0	8.54	8.57	8.6	8.6	8.6	0.25	0	5.28	5.35	5.39	5.39	5.35	0.25	0	7.23	7.26	7.38	7.59	7.89
	0.25	8.44	8.48	8.5	8.51	8.5		0.25	5.33	5.41	5.44	5.44	5.4		0.25	7.47	7.5	7.63	7.84	8.13
	0.5	8.41	8.44	8.47	8.48	8.47		0.5	5.35	5.43	5.46	5.46	5.42		0.5	7.55	7.59	7.71	7.92	8.21
	0.75	8.43	8.47	8.49	8.5	8.49		0.75	5.34	5.41	5.45	5.45	5.41		0.75	7.47	7.5	7.63	7.83	8.13
	1	8.51	8.55	8.57	8.58	8.57		1	5.3	5.37	5.41	5.4	5.36		1	7.23	7.26	7.38	7.59	7.89
0.5	0	8.56	8.6	8.62	8.63	8.62	0.5	0	5.31	5.39	5.42	5.42	5.38	0.5	0	7.21	7.24	7.36	7.57	7.87
	0.25	8.47	8.5	8.53	8.53	8.53		0.25	5.36	5.44	5.47	5.47	5.43		0.25	7.45	7.48	7.6	7.81	8.11
	0.5	8.43	8.47	8.49	8.5	8.49		0.5	5.38	5.46	5.49	5.49	5.45		0.5	7.53	7.56	7.68	7.89	8.19
	0.75	8.45	8.49	8.51	8.52	8.51		0.75	5.37	5.44	5.48	5.48	5.44		0.75	7.45	7.48	7.6	7.81	8.11
	1	8.53	8.57	8.6	8.6	8.6		1	5.33	5.4	5.44	5.43	5.39		1	7.21	7.24	7.36	7.57	7.87
0.75	0	8.62	8.66	8.69	8.69	8.69	0.75	0	5.32	5.39	5.43	5.42	5.39	0.75	0	7.28	7.31	7.43	7.64	7.94
	0.25	8.53	8.57	8.59	8.6	8.59		0.25	5.37	5.44	5.48	5.48	5.44		0.25	7.52	7.55	7.67	7.88	8.18
	0.5	8.5	8.53	8.56	8.56	8.56		0.5	5.39	5.46	5.5	5.5	5.46		0.5	7.6	7.63	7.76	7.97	8.26
	0.75	8.52	8.56	8.58	8.59	8.58		0.75	5.38	5.45	5.49	5.48	5.44		0.75	7.52	7.55	7.67	7.88	8.18
	1	8.6	8.64	8.66	8.67	8.66		1	5.33	5.41	5.44	5.44	5.4		1	7.28	7.31	7.43	7.64	7.94
1	0	8.73	8.77	8.79	8.8	8.79	1	0	5.3	5.37	5.41	5.41	5.37	1	0	7.44	7.48	7.6	7.81	8.11
	0.25	8.64	8.68	8.7	8.71	8.7		0.25	5.35	5.42	5.46	5.46	5.42		0.25	7.69	7.72	7.84	8.05	8.35
	0.5	8.6	8.64	8.67	8.67	8.67		0.5	5.37	5.44	5.48	5.48	5.44		0.5	7.77	7.8	7.92	8.13	8.43
	0.75	8.63	8.67	8.69	8.7	8.69		0.75	5.36	5.43	5.47	5.47	5.43		0.75	7.69	7.72	7.84	8.05	8.35
	1	8.71	8.75	8.77	8.78	8.77		1	5.32	5.39	5.42	5.42	5.38		1	7.44	7.48	7.6	7.81	8.1

1995

Aberdeen 1995							Morley 1995							Rosemaund 1995						
		GS30							GS30							GS30				
GS31/2	GS39/49	0	0.25	0.5	0.75	1	GS31/2	GS39/49	0	0.25	0.5	0.75	1	GS31/2	GS39/49	0	0.25	0.5	0.75	1
0	0	8.05	8.11	8.17	8.24	8.3	0	0	5.63	6	6.25	6.37	6.37	0	0	5.89	6.04	6.06	5.95	5.71
	0.25	8.23	8.3	8.36	8.42	8.49		0.25	6.1	6.46	6.7	6.82	6.81		0.25	5.93	6.08	6.1	5.99	5.75
	0.5	8.42	8.48	8.55	8.61	8.67		0.5	6.44	6.79	7.03	7.13	7.12		0.5	5.97	6.12	6.14	6.03	5.79
	0.75	8.61	8.67	8.73	8.8	8.86		0.75	6.65	7	7.22	7.32	7.3		0.75	6.01	6.16	6.18	6.07	5.83
	1	8.79	8.86	8.92	8.99	9.05		1	6.74	7.08	7.29	7.38	7.35		1	6.05	6.2	6.22	6.11	5.87
0.25	0	8.58	8.64	8.71	8.77	8.83	0.25	0	6.3	6.67	6.92	7.04	7.04	0.25	0	5.96	6.11	6.13	6.02	5.78
	0.25	8.77	8.83	8.89	8.96	9.02		0.25	6.74	7.1	7.34	7.46	7.45		0.25	5.98	6.12	6.14	6.03	5.8
	0.5	8.95	9.02	9.08	9.14	9.21		0.5	7.05	7.41	7.64	7.75	7.73		0.5	5.99	6.14	6.16	6.05	5.81
	0.75	9.14	9.2	9.27	9.33	9.39		0.75	7.24	7.59	7.81	7.91	7.88		0.75	6	6.15	6.17	6.06	5.82
	1	9.33	9.39	9.45	9.52	9.58		1	7.3	7.63	7.85	7.94	7.91		1	6.02	6.17	6.19	6.08	5.84
0.5	0	8.91	8.97	9.04	9.1	9.16	0.5	0	6.74	7.11	7.36	7.48	7.48	0.5	0	6.04	6.19	6.2	6.1	5.86
	0.25	9.1	9.16	9.22	9.29	9.35		0.25	7.15	7.51	7.75	7.87	7.86		0.25	6.02	6.17	6.19	6.08	5.84
	0.5	9.28	9.35	9.41	9.47	9.54		0.5	7.44	7.79	8.02	8.13	8.11		0.5	6.01	6.16	6.18	6.07	5.83
	0.75	9.47	9.53	9.6	9.66	9.73		0.75	7.59	7.94	8.16	8.26	8.24		0.75	6	6.15	6.17	6.06	5.82
	1	9.66	9.72	9.79	9.85	9.91		1	7.62	7.96	8.18	8.27	8.23		1	5.99	6.14	6.16	6.05	5.81
0.75	0	9.04	9.11	9.17	9.23	9.3	0.75	0	6.95	7.32	7.57	7.69	7.69	0.75	0	6.11	6.26	6.28	6.17	5.93
	0.25	9.23	9.29	9.36	9.42	9.48		0.25	7.33	7.7	7.94	8.05	8.04		0.25	6.07	6.22	6.24	6.13	5.89
	0.5	9.42	9.48	9.54	9.61	9.67		0.5	7.59	7.95	8.18	8.28	8.27		0.5	6.03	6.18	6.2	6.09	5.85
	0.75	9.6	9.67	9.73	9.79	9.86		0.75	7.72	8.07	8.29	8.39	8.36		0.75	6	6.15	6.17	6.06	5.82
	1	9.79	9.85	9.92	9.98	10.04		1	7.72	8.06	8.27	8.36	8.33		1	5.96	6.11	6.13	6.02	5.78
1	0	8.97	9.04	9.1	9.16	9.23	1	0	6.93	7.3	7.54	7.67	7.67	1	0	6.19	6.33	6.35	6.24	6.01
	0.25	9.16	9.22	9.29	9.35	9.41		0.25	7.28	7.65	7.89	8	7.99		0.25	6.12	6.27	6.29	6.18	5.94
	0.5	9.35	9.41	9.47	9.54	9.6		0.5	7.51	7.87	8.1	8.21	8.19		0.5	6.06	6.21	6.23	6.12	5.88
	0.75	9.53	9.6	9.66	9.72	9.79		0.75	7.61	7.96	8.18	8.28	8.26		0.75	5.99	6.14	6.16	6.05	5.81
	1	9.72	9.78	9.85	9.91	9.97		1	7.59	7.92	8.14	8.23	8.2		1	5.93	6.08	6.1	5.99	5.75

1996

Aberdeen 1996							Morley 1996							Rosemaund 1996						
		GS30							GS30							GS30				
GS31/2	GS39/49	0	0.25	0.5	0.75	1	GS31/2	GS39/49	0	0.25	0.5	0.75	1	GS31/2	GS39/49	0	0.25	0.5	0.75	1
0	0	7.72	7.87	8.03	8.18	8.33	0	0	7.03	7.09	7.13	7.14	7.12	0	0	6.5	6.62	6.73	6.85	6.96
	0.25	8.23	8.34	8.45	8.55	8.66		0.25	7.13	7.2	7.24	7.25	7.22		0.25	6.69	6.76	6.82	6.89	6.95
	0.5	8.57	8.63	8.7	8.76	8.82		0.5	7.17	7.24	7.28	7.29	7.27		0.5	6.88	6.9	6.91	6.93	6.94
	0.75	8.73	8.75	8.77	8.79	8.81		0.75	7.16	7.22	7.26	7.27	7.25		0.75	7.07	7.04	7	6.97	6.93
	1	8.72	8.7	8.68	8.65	8.63		1	7.07	7.14	7.18	7.19	7.16		1	7.26	7.17	7.09	7.01	6.92
0.25	0	7.97	8.12	8.27	8.42	8.57	0.25	0	7.18	7.24	7.28	7.29	7.27	0.25	0	8.06	8.17	8.29	8.4	8.52
	0.25	8.48	8.59	8.69	8.8	8.91		0.25	7.28	7.35	7.39	7.4	7.37		0.25	8.25	8.31	8.38	8.44	8.51
	0.5	8.82	8.88	8.94	9.01	9.07		0.5	7.33	7.39	7.43	7.44	7.42		0.5	8.43	8.45	8.47	8.48	8.5
	0.75	8.98	9	9.02	9.04	9.06		0.75	7.31	7.37	7.41	7.42	7.4		0.75	8.62	8.59	8.55	8.52	8.49
	1	8.97	8.95	8.92	8.9	8.87		1	7.22	7.29	7.33	7.34	7.31		1	8.81	8.73	8.64	8.56	8.48
0.5	0	8.22	8.37	8.52	8.67	8.82	0.5	0	7.25	7.32	7.35	7.36	7.34	0.5	0	8.66	8.78	8.89	9.01	9.12
	0.25	8.73	8.83	8.94	9.05	9.15		0.25	7.35	7.42	7.46	7.47	7.44		0.25	8.85	8.91	8.98	9.05	9.11
	0.5	9.06	9.13	9.19	9.25	9.32		0.5	7.4	7.46	7.5	7.51	7.49		0.5	9.04	9.05	9.07	9.08	9.1
	0.75	9.23	9.25	9.26	9.28	9.3		0.75	7.38	7.45	7.48	7.49	7.47		0.75	9.23	9.19	9.16	9.12	9.09
	1	9.22	9.19	9.17	9.14	9.12		1	7.29	7.36	7.4	7.41	7.38		1	9.41	9.33	9.25	9.16	9.08
0.75	0	8.46	8.61	8.76	8.91	9.06	0.75	0	7.24	7.31	7.35	7.35	7.33	0.75	0	8.31	8.43	8.54	8.66	8.77
	0.25	8.97	9.08	9.18	9.29	9.4		0.25	7.35	7.41	7.45	7.46	7.44		0.25	8.5	8.57	8.63	8.7	8.76
	0.5	9.31	9.37	9.43	9.5	9.56		0.5	7.39	7.46	7.5	7.5	7.48		0.5	8.69	8.71	8.72	8.74	8.75
	0.75	9.47	9.49	9.51	9.53	9.55		0.75	7.37	7.44	7.48	7.48	7.46		0.75	8.88	8.85	8.81	8.78	8.74
	1	9.46	9.44	9.41	9.39	9.37		1	7.29	7.36	7.39	7.4	7.38		1	9.07	8.98	8.9	8.82	8.73
1	0	8.71	8.86	9.01	9.16	9.31	1	0	7.15	7.22	7.26	7.27	7.24	1	0	7.02	7.13	7.25	7.36	7.48
	0.25	9.22	9.32	9.43	9.54	9.64		0.25	7.26	7.33	7.37	7.37	7.35		0.25	7.21	7.27	7.34	7.4	7.47
	0.5	9.55	9.62	9.68	9.74	9.81		0.5	7.3	7.37	7.41	7.42	7.39		0.5	7.39	7.41	7.43	7.44	7.46
	0.75	9.72	9.74	9.76	9.78	9.8		0.75	7.28	7.35	7.39	7.4	7.37		0.75	7.58	7.55	7.51	7.48	7.45
	1	9.71	9.68	9.66	9.63	9.61		1	7.2	7.27	7.31	7.31	7.29		1	7.77	7.69	7.6	7.52	7.44

Appendix 3

Area Under Disease Progress Curves for all leaf layers on all treatments at all sites

ABERDEEN 1994: AREA UNDER DISEASE PROGRESS CURVE: RHYNCHOSPORIUM										
TREAT	LEAF 1	LEAF 2	LEAF 3	LEAF 4	LEAF 5	LEAF 6	LEAF 7	LEAF 8	LEAF 9	LEAF 10
1	1.7	80.8	80.8	526.1	100.3	54.6	182.2	32.5	7.3	0.0
2	0.0	17.3	17.3	594.0	82.9	26.8	136.5	18.4	7.9	4.6
3	1.7	8.6	8.6	653.0	70.9	102.4	336.5	61.7	22.0	9.0
4	0.0	15.4	15.4	485.8	102.4	70.9	235.2	50.9	14.2	0.8
5	0.0	17.9	17.9	592.3	112.3	21.0	87.9	48.3	44.1	3.9
6	5.6	74.8	74.8	484.4	88.7	119.2	302.4	6.7	55.7	9.2
7	0.4	73.6	73.6	447.5	61.4	29.9	119.2	36.8	8.8	2.9
8	0.0	53.8	53.8	439.0	50.7	43.6	163.3	34.7	21.5	3.7
9	0.0	30.8	30.8	547.3	165.9	139.6	299.8	64.2	41.6	0.0
10	0.0	7.2	7.2	697.9	138.1	29.9	142.3	61.7	21.2	5.3
11	0.0	15.7	15.7	909.1	117.6	101.3	222.6	70.9	6.3	0.0
12	0.0	0.0	0.0	648.4	120.8	49.3	135.4	61.4	17.5	5.9
13	0.0	0.5	0.5	604.5	97.1	38.8	100.3	170.6	263.0	3.0
14	0.9	34.1	34.1	1004.8	64.6	47.8	124.4	94.5	3.6	0.0
15	0.0	2.5	2.5	239.5	45.7	83.5	278.8	70.9	27.3	5.3
16	0.0	0.4	0.4	339.1	33.1	42.5	106.1	35.7	8.4	5.3
17	0.4	13.4	13.4	273.9	58.8	67.2	296.6	153.8	9.3	1.7
18	0.4	11.3	11.3	452.2	49.9	25.7	154.4	137.6	3.5	1.5
19	0.4	4.9	4.9	234.1	21.5	29.4	91.9	42.5	21.0	15.8
20	0.0	0.0	0.0	364.4	59.8	107.6	154.4	128.1	37.8	0.0
21	0.0	5.9	5.9	342.4	27.8	27.3	110.8	56.7	0.0	0.3
22	0.0	3.4	3.4	194.9	31.0	37.8	92.1	30.6	33.1	3.5
23	0.0	3.8	3.8	245.6	17.3	33.1	139.6	41.5	0.0	0.0
24	0.0	4.0	4.0	442.3	55.1	41.0	92.3	90.8	36.8	3.7
25	0.0	0.9	0.9	281.9	17.3	94.0	204.2	79.3	33.6	8.7
26	0.0	0.5	0.5	307.1	41.5	61.4	156.4	86.1	6.3	20.3
27	0.0	0.4	0.4	258.8	39.9	57.8	328.1	58.3	14.0	6.3
28	0.0	4.9	4.9	458.5	14.7	14.7	170.1	12.6	16.4	6.0
29	0.0	4.7	4.7	202.1	31.0	47.3	170.6	9.4	4.1	4.0
30	0.0	1.8	1.8	410.2	15.8	25.0	237.8	37.7	57.8	0.0
31	0.0	1.6	1.6	223.6	54.1	37.8	136.5	15.8	5.3	2.0
32	0.0	0.0	0.0	161.1	23.1	32.0	130.2	64.2	0.0	0.0
33	0.0	0.0	0.0	251.9	46.2	90.8	254.7	90.3	6.6	0.0
34	5.5	4.7	4.7	266.5	10.5	49.3	243.6	160.1	21.0	0.0
35	0.0	0.0	0.0	157.2	25.2	50.9	135.4	45.7	2.9	0.0
36	0.0	6.8	6.8	275.6	48.8	65.6	98.7	34.1	5.3	0.7
37	0.0	1.6	1.6	450.5	34.1	90.8	168.0	103.9	57.8	5.3
38	0.0	4.3	4.3	167.1	15.2	44.6	219.4	57.8	0.9	0.0
39	0.0	0.9	0.9	155.1	31.0	26.3	185.9	141.2	15.9	6.0
40	0.0	2.8	2.8	310.1	30.1	32.2	169.1	56.5	13.1	0.0

ABERDEEN 1994: AREA UNDER DISEASE PROGRESS CURVE: MILDEW										
TREAT	LEAF 1	LEAF 2	LEAF 3	LEAF 4	LEAF 5	LEAF 6	LEAF 7	LEAF 8	LEAF 9	LEAF 10
1	0.0	0.9	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.7	0.7	0.0	0.0	0.0	0.0	0.0	0.0	1.6
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.7	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.4
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	11.0
12	0.0	0.7	0.7	0.0	0.0	0.0	0.0	0.0	0.0	1.2
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.9	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	7.5
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5
25	0.0	0.9	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3
28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
29	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
31	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	17.8
32	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
33	0.0	1.4	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
34	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
35	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
36	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
37	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
38	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0
39	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0
40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

MORLEY 1994: AREA UNDER DISEASE PROGRESS CURVE: RHYNCHOSPORIUM									
TREAT	LEAF 1	LEAF 2	LEAF 3	LEAF 4	LEAF 5	LEAF 6	LEAF 7	LEAF 8	LEAF 9
1	3.1	20.3	12.1	44.0	0.0	10.5	16.6	*	4.8
2	3.1	17.3	9.9	23.2	0.0	7.6	27.4	*	1.5
3	3.3	15.3	10.8	27.1	0.0	5.0	8.4	*	6.3
4	2.7	13.5	5.4	20.1	0.0	10.5	40.8	*	7.2
5	2.8	13.1	6.3	29.1	1.1	7.1	12.8	*	6.0
6	5.5	15.4	7.4	31.4	0.0	4.7	18.8	*	0.0
7	1.1	9.7	3.1	28.2	0.0	7.4	27.9	*	0.6
8	0.1	11.0	3.3	28.9	0.0	12.6	26.1	*	0.0
9	0.4	5.8	2.9	39.0	0.0	12.3	50.0	*	3.0
10	2.6	6.1	2.5	24.2	0.3	3.9	17.5	*	0.9
11	0.7	8.6	1.8	21.4	0.0	8.4	10.7	*	0.2
12	0.3	7.2	2.2	22.2	0.0	5.0	13.0	*	4.8
13	0.8	3.6	0.9	14.0	0.0	4.2	16.1	*	1.2
14	1.3	11.8	6.0	35.2	0.0	9.3	24.7	*	9.9
15	11.5	15.2	10.5	9.7	0.5	10.2	20.7	*	4.8
16	0.2	7.5	3.5	13.4	0.0	12.3	12.7	*	6.6
17	0.7	4.8	1.8	12.6	0.0	6.3	17.6	*	1.2
18	1.0	6.7	2.4	27.1	0.0	12.1	15.4	*	0.0
19	0.9	7.9	3.5	27.4	0.0	3.2	6.2	*	9.6
20	0.7	1.6	0.9	23.7	0.0	10.1	30.2	*	0.0
21	2.3	12.5	8.1	46.2	0.0	3.7	11.1	*	1.9
22	1.6	16.1	6.1	16.7	0.0	9.0	9.0	*	7.2
23	0.9	8.5	4.0	15.2	0.0	9.2	25.0	*	0.0
24	1.3	6.5	4.0	21.8	0.5	3.9	12.5	*	0.0
25	4.5	3.3	1.7	18.9	0.0	4.4	24.7	*	18.0
26	0.2	2.9	0.5	13.0	0.3	7.2	17.1	*	12.0
27	0.1	1.5	0.7	12.7	0.3	6.1	15.3	*	6.0
28	2.3	12.2	4.0	18.0	0.0	8.9	13.3	*	2.4
29	1.7	7.6	4.0	14.9	0.0	2.1	9.2	*	5.3
30	0.8	6.9	1.3	21.4	0.0	0.8	9.2	*	9.6
31	7.1	2.3	0.9	12.8	0.5	9.6	33.5	*	4.3
32	0.9	2.2	1.3	12.4	0.0	7.2	27.2	*	12.0
33	0.1	2.6	1.5	12.2	0.0	3.9	14.2	*	0.0
34	0.7	52.9	49.8	17.0	0.0	4.2	10.0	*	7.2
35	0.4	4.3	2.8	10.3	0.0	5.4	15.0	*	5.1
36	1.9	1.8	0.2	14.3	0.0	5.5	13.6	*	9.6
37	0.7	5.0	1.3	16.0	0.0	9.7	21.0	*	20.0
38	0.2	5.0	1.3	15.4	0.0	5.8	21.2	*	0.7
39	0.7	3.4	0.9	16.6	0.0	4.7	9.9	*	0.6
40	0.9	6.5	3.8	14.7	0.0	14.4	20.2	*	0.8

MORLEY 1994: AREA UNDER DISEASE PROGRESS CURVE: BROWN RUST									
TREAT	LEAF 1	LEAF 2	LEAF 3	LEAF 4	LEAF 5	LEAF 6	LEAF 7	LEAF 8	LEAF 9
1	2.1	4.4	2.1	3.7	0.0	0.3	0.5	*	0.0
2	0.8	1.0	0.5	0.2	0.0	0.2	0.6	*	0.3
3	1.3	2.6	2.0	2.2	0.0	0.4	0.7	*	0.2
4	0.6	0.9	0.5	0.2	0.0	0.6	1.4	*	0.0
5	0.7	1.4	0.8	0.1	0.0	0.3	1.4	*	0.0
6	0.3	0.4	0.2	2.4	0.0	0.3	0.9	*	0.0
7	0.1	0.3	0.1	2.6	0.0	0.1	2.7	*	0.0
8	0.1	0.0	0.0	2.4	0.0	0.3	0.1	*	0.0
9	0.1	0.0	0.0	2.6	0.0	0.2	0.6	*	0.2
10	0.1	0.2	0.1	0.2	0.0	0.2	0.3	*	0.0
11	0.1	0.1	0.0	0.0	0.0	0.0	0.3	*	0.0
12	0.1	0.2	0.1	0.0	0.0	0.2	0.5	*	0.0
13	0.0	0.0	0.0	0.0	0.0	0.1	1.3	*	0.2
14	0.9	2.2	1.5	1.3	0.0	0.2	0.7	*	0.0
15	0.5	2.9	1.2	0.2	0.0	0.1	0.2	*	0.0
16	0.2	0.1	0.0	0.1	0.0	0.2	1.8	*	0.2
17	0.1	0.1	0.0	0.0	0.0	0.0	0.3	*	0.0
18	0.1	0.1	0.0	0.4	0.0	0.1	0.3	*	0.0
19	0.0	0.1	0.0	0.1	0.0	0.0	1.1	*	0.0
20	0.0	0.0	0.0	0.0	0.0	0.2	0.5	*	0.1
21	0.6	1.7	1.0	1.1	0.0	0.0	0.1	*	0.0
22	0.3	0.8	0.3	0.1	0.0	0.0	5.6	*	0.1
23	0.2	0.2	0.0	0.0	0.0	0.1	0.4	*	0.0
24	0.1	0.1	0.0	0.4	0.0	0.1	0.6	*	0.0
25	0.0	0.0	0.0	0.0	0.0	0.0	0.6	*	0.0
26	0.0	0.0	0.0	0.1	0.0	0.2	0.6	*	0.0
27	0.1	0.1	0.0	0.0	0.0	0.2	0.4	*	0.0
28	0.7	1.6	1.2	1.0	0.0	0.0	0.1	*	0.2
29	0.1	0.5	0.2	0.0	0.0	0.3	0.4	*	0.0
30	0.0	0.1	0.0	0.5	0.0	0.1	0.9	*	0.0
31	0.0	0.1	0.0	0.0	0.0	0.2	0.7	*	0.1
32	0.0	0.1	0.0	0.0	0.0	0.1	0.7	*	0.0
33	0.1	0.0	0.0	0.0	0.0	0.0	0.4	*	0.0
34	0.5	1.8	1.2	1.5	0.0	0.1	10.5	*	0.0
35	0.1	0.1	0.0	0.0	0.0	0.0	0.1	*	0.0
36	0.1	0.1	0.0	0.0	0.0	0.0	0.0	*	0.0
37	0.1	0.0	0.0	0.0	0.0	0.0	0.6	*	0.0
38	0.0	0.1	0.0	0.1	0.0	0.0	0.6	*	0.0
39	0.0	0.0	0.0	0.0	0.0	0.0	0.1	*	0.0
40	0.1	0.2	0.0	0.0	0.0	0.2	1.1	*	0.0

MORLEY 1994: AREA UNDER DISEASE PROGRESS CURVE: MILDEW									
TREAT	LEAF 1	LEAF 2	LEAF 3	LEAF 4	LEAF 5	LEAF 6	LEAF 7	LEAF 8	LEAF 9
1	0.3	0.9	0.2	0.2	0.0	0.0	1.1	*	0.0
2	0.1	0.2	0.2	0.0	0.0	0.0	2.9	*	0.0
3	2.7	2.1	2.0	0.0	0.0	1.4	3.3	*	0.6
4	0.6	1.1	1.1	0.0	0.0	0.0	1.1	*	0.0
5	0.3	0.8	0.4	0.0	0.0	0.0	0.0	*	0.0
6	0.0	0.1	0.0	0.2	0.0	0.3	4.4	*	0.0
7	0.0	0.2	0.2	1.4	0.0	0.0	0.1	*	0.0
8	0.0	0.0	0.0	0.4	0.0	0.0	0.0	*	0.0
9	0.0	0.2	0.0	0.0	0.0	0.0	5.3	*	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	4.6	*	0.0
11	0.0	0.0	0.0	0.0	0.0	0.3	3.0	*	0.2
12	0.0	0.0	0.0	0.0	0.0	0.0	34.9	*	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	7.1	*	0.1
14	0.0	0.7	0.5	0.0	0.0	0.0	3.4	*	0.4
15	0.2	1.7	1.1	0.2	0.0	0.0	3.8	*	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	8.2	*	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	1.9	*	0.0
18	0.0	0.2	0.2	1.1	0.0	0.0	1.3	*	0.0
19	0.0	0.0	0.0	0.0	0.0	0.3	2.3	*	1.9
20	0.0	0.0	0.0	0.0	0.0	0.0	1.3	*	0.0
21	0.4	1.5	0.2	0.4	0.0	0.0	1.1	*	0.0
22	0.2	0.1	0.1	0.0	0.0	0.0	0.8	*	0.0
23	0.0	0.2	0.1	0.0	0.0	0.0	0.0	*	0.0
24	0.0	0.0	0.0	0.0	0.0	0.1	0.4	*	0.9
25	0.0	0.0	0.0	0.2	0.0	0.0	9.5	*	0.2
26	0.0	0.0	0.0	0.2	0.0	0.0	5.1	*	2.4
27	0.0	0.0	0.0	0.0	0.0	0.7	3.2	*	0.0
28	0.7	0.4	0.4	0.0	0.0	0.0	1.2	*	0.1
29	0.0	0.4	0.2	0.0	0.0	0.3	1.7	*	0.0
30	0.0	0.0	0.0	0.4	0.0	0.7	4.3	*	1.5
31	0.0	0.2	0.0	0.0	0.0	0.3	1.7	*	0.0
32	0.0	0.0	0.0	0.0	0.0	0.0	4.3	*	0.0
33	0.0	0.0	0.0	0.0	0.0	0.0	0.7	*	0.3
34	0.3	0.4	0.4	0.0	0.0	0.5	1.1	*	0.0
35	0.0	0.1	0.0	0.2	0.0	0.0	4.4	*	0.0
36	0.0	0.0	0.0	0.0	0.0	0.0	0.0	*	0.0
37	0.0	0.0	0.0	0.0	0.0	0.0	2.1	*	0.0
38	0.0	0.0	0.0	0.0	0.0	0.0	5.0	*	0.0
39	0.0	0.0	0.0	0.0	0.0	0.0	3.1	*	0.0
40	0.0	0.1	0.0	0.0	0.0	0.7	2.4	*	0.0

MORLEY 1994: AREA UNDER DISEASE PROGRESS CURVE: NET BLOTCH									
TREAT	LEAF 1	LEAF 2	LEAF 3	LEAF 4	LEAF 5	LEAF 6	LEAF 7	LEAF 8	LEAF 9
1	2.6	5.1	3.7	3.2	0.0	5.8	25.5	*	3.6
2	3.1	8.4	4.3	4.9	0.5	5.7	69.7	*	0.0
3	2.5	4.4	4.2	12.7	0.0	20.7	32.8	*	7.2
4	1.1	13.6	9.7	3.3	0.0	12.3	16.9	*	2.3
5	0.7	6.1	1.8	5.2	0.0	6.0	20.8	*	0.0
6	0.4	5.4	4.0	9.4	0.0	8.0	24.6	*	4.8
7	0.4	3.5	3.3	6.7	0.0	9.9	10.8	*	0.6
8	0.4	1.8	1.4	6.1	0.0	13.3	19.8	*	1.3
9	0.5	3.7	3.0	7.2	0.0	18.0	34.0	*	0.6
10	0.3	2.4	2.2	5.8	0.0	9.7	30.2	*	0.0
11	0.6	4.1	3.3	6.4	0.0	10.3	24.6	*	0.0
12	0.6	3.9	3.1	8.6	0.0	16.7	21.1	*	0.8
13	0.2	1.1	1.1	9.4	2.4	26.7	49.2	*	16.2
14	0.7	6.9	2.6	13.1	1.3	14.3	17.6	*	8.0
15	0.9	5.2	4.8	4.4	0.5	11.3	37.1	*	0.1
16	3.0	6.2	3.6	9.3	0.0	10.3	29.0	*	0.9
17	0.0	2.7	1.9	15.3	0.0	8.1	19.6	*	10.8
18	0.8	3.3	2.3	6.3	0.0	13.1	13.1	*	3.7
19	0.7	4.2	1.6	8.4	0.5	22.4	56.4	*	7.8
20	1.1	1.2	0.9	1.6	0.0	8.2	13.2	*	0.6
21	0.7	4.5	3.7	5.3	0.0	7.3	23.5	*	0.1
22	0.9	6.2	3.6	4.9	0.0	14.4	44.5	*	2.4
23	0.2	2.2	1.3	3.9	0.5	6.5	16.3	*	0.7
24	0.0	2.5	2.5	9.8	0.0	6.4	16.7	*	3.6
25	0.2	1.1	0.7	4.6	0.0	12.6	25.7	*	4.8
26	0.6	3.4	2.5	4.6	0.0	15.5	25.6	*	2.4
27	1.2	0.4	0.4	3.7	0.0	7.5	15.5	*	7.8
28	0.7	4.5	2.0	4.5	0.0	5.7	27.3	*	4.9
29	0.5	9.6	4.4	8.2	0.0	10.6	27.9	*	0.0
30	0.9	7.5	3.4	12.4	0.0	12.3	23.1	*	0.0
31	0.0	1.4	0.4	3.0	0.0	20.3	33.7	*	1.2
32	0.4	1.4	1.4	1.7	0.0	4.7	6.1	*	2.4
33	0.0	2.2	0.7	7.5	0.0	17.6	20.0	*	0.6
34	1.6	4.1	2.5	12.7	0.0	19.6	21.0	*	0.6
35	0.4	3.1	1.9	2.1	0.0	3.1	17.0	*	0.9
36	0.0	1.6	1.4	3.9	0.0	12.8	11.7	*	13.2
37	0.0	0.8	0.7	2.6	0.0	14.1	18.9	*	1.2
38	0.6	5.9	2.5	0.9	0.0	9.7	13.9	*	0.0
39	0.0	1.2	0.2	3.5	0.0	13.5	25.9	*	2.4
40	0.0	2.6	2.0	8.6	0.0	17.6	34.5	*	2.3

ROSEMAUND 1994: AREA UNDER DISEASE PROGRESS CURVE: MILDEW											
TREAT	LEAF 1	LEAF 2	LEAF 3	LEAF 4	LEAF 5	LEAF 6	LEAF 7	LEAF 8	LEAF 9	LEAF 1	LEAF 1
1	85.6	314.9	488.5	240.2	17.5	169.8	471.1	200.9	73.0	46.6	48.3
2	44.0	174.1	226.1	31.5	7.6	119.1	320.8	143.9	96.6	81.6	0.0
3	27.1	113.7	135.6	32.0	2.7	151.1	599.1	146.3	87.3	43.6	7.0
4	31.8	162.5	108.6	20.3	2.5	122.3	385.0	200.4	168.9	83.2	0.0
5	25.3	122.7	133.6	31.4	2.0	118.3	472.9	291.4	114.5	61.4	1.8
6	4.3	132.6	353.5	318.1	13.3	111.3	211.3	143.8	146.2	66.9	0.0
7	1.9	60.2	235.9	74.3	9.0	209.9	523.5	239.7	168.1	51.7	0.3
8	2.1	38.4	192.5	181.3	25.8	227.1	636.4	181.0	97.0	54.4	28.0
9	2.8	67.9	254.8	87.2	27.8	202.1	594.5	146.0	87.6	66.3	1.8
10	0.9	21.1	143.8	77.2	5.5	103.4	410.6	119.8	94.6	95.2	0.0
11	1.2	28.4	100.6	30.9	2.7	140.7	420.2	187.5	119.7	76.8	10.5
12	6.6	33.4	90.0	26.8	3.2	84.1	366.4	170.0	125.8	84.3	15.8
13	4.0	23.5	108.7	80.8	6.1	130.1	523.8	187.8	121.2	40.7	6.7
14	70.9	170.6	278.8	39.8	3.3	34.7	187.1	134.9	114.6	152.9	7.0
15	45.2	314.9	324.0	72.1	0.0	72.7	323.4	161.1	217.9	78.7	33.2
16	3.3	26.8	54.1	23.8	0.0	100.9	365.6	128.7	120.7	53.4	15.8
17	5.5	25.9	124.4	102.2	2.0	61.1	298.3	153.1	87.1	55.5	17.9
18	3.1	16.3	107.1	85.2	1.4	80.4	284.0	147.4	106.6	87.4	0.0
19	3.0	22.4	75.4	40.8	0.0	51.7	218.0	120.1	105.3	62.1	7.0
20	0.6	10.6	53.2	33.2	14.6	61.7	364.8	163.5	60.2	67.2	14.0
21	31.3	131.5	296.1	101.6	0.7	39.2	202.0	120.2	96.8	34.7	4.5
22	25.9	99.7	204.2	43.2	0.7	82.9	238.5	119.2	125.2	91.0	12.3
23	2.6	25.6	102.9	28.0	3.1	100.2	365.3	204.9	175.8	79.8	0.0
24	2.4	18.7	124.4	80.5	1.4	52.9	390.1	157.1	220.8	143.0	17.5
25	1.6	13.3	47.9	13.7	5.3	65.8	317.4	169.0	106.7	70.6	1.1
26	3.2	12.9	71.2	40.7	1.8	70.7	352.6	182.7	98.9	100.6	14.0
27	2.0	16.7	65.7	37.5	4.0	56.0	219.9	134.9	100.2	48.9	11.5
28	33.8	134.6	152.9	44.5	3.1	74.2	439.3	163.3	182.5	95.9	38.5
29	31.6	105.9	108.4	54.2	3.6	57.6	181.1	166.3	136.8	116.7	0.0
30	8.9	39.3	93.2	34.5	2.0	99.8	229.6	107.3	113.7	74.5	36.0
31	6.0	12.4	43.0	18.7	3.4	50.4	236.4	88.9	85.7	102.8	42.0
32	0.5	13.4	65.7	15.8	2.0	32.7	284.5	109.2	104.9	51.8	10.5
33	1.2	16.9	34.1	28.4	4.1	82.4	245.0	131.5	95.2	46.7	19.3
34	30.2	125.9	125.9	57.4	1.4	60.3	220.4	148.9	120.4	138.1	0.0
35	2.1	32.9	42.4	27.5	1.7	62.0	118.8	135.2	128.0	46.9	3.5
36	0.6	9.8	34.3	26.4	14.7	88.3	334.0	141.9	151.6	46.7	9.1
37	3.1	19.3	76.1	47.4	0.6	111.1	328.7	166.5	88.4	53.9	7.0
38	1.9	13.6	55.4	11.9	4.4	86.7	412.8	124.8	132.9	95.8	35.0
39	2.7	11.2	33.7	19.6	19.6	45.0	333.4	144.6	84.7	80.2	21.7
40	67.7	410.4	538.9	301.8	20.9	215.2	463.7	201.9	107.8	116.2	32.0

ROSEMAUND 1994: AREA UNDER DISEASE PROGRESS CURVE: RHYNCHOSPORIUM											
TREAT	LEAF 1	LEAF 2	LEAF 3	LEAF 4	LEAF 5	LEAF 6	LEAF 7	LEAF 8	LEAF 9	LEAF 1	LEAF 1
1	8.6	13.6	113.5	188.4	0.6	20.3	45.2	57.1	33.4	15.6	18.5
2	4.1	17.3	127.7	115.8	0.0	4.2	43.3	70.1	58.5	39.1	0.0
3	4.2	10.2	59.9	36.9	1.3	17.0	23.4	73.7	13.6	38.0	1.8
4	7.6	15.8	74.5	45.4	1.7	12.6	55.0	52.8	49.2	19.0	0.0
5	1.2	7.3	79.7	50.6	0.6	14.1	41.9	93.1	46.7	25.5	0.0
6	0.5	18.6	156.0	220.6	46.2	76.5	141.6	84.9	74.7	32.5	0.0
7	0.2	14.7	157.3	165.1	0.6	12.3	39.2	105.4	85.3	19.2	0.3
8	0.9	18.1	132.6	124.6	2.1	9.9	50.6	50.5	32.8	37.4	0.0
9	1.0	14.6	91.1	144.1	0.6	14.2	46.2	41.0	29.0	16.1	0.0
10	0.0	7.4	127.0	107.6	0.6	16.8	34.7	74.1	39.0	27.2	0.0
11	0.0	3.3	98.8	91.7	4.2	20.0	87.8	75.3	45.3	56.7	0.0
12	0.8	1.2	82.1	33.3	0.6	10.4	48.4	72.1	82.9	28.2	26.3
13	1.1	4.3	62.8	101.9	1.1	19.6	39.5	54.6	44.9	17.1	16.1
14	7.5	14.6	67.3	133.5	1.3	7.8	24.9	40.2	26.7	9.1	7.0
15	3.7	2.5	47.9	41.7	4.2	16.5	91.3	104.0	48.3	29.8	1.0
16	0.5	2.0	33.1	33.8	0.6	13.8	49.7	48.0	51.9	16.5	17.5
17	0.0	1.9	42.2	61.6	0.6	11.1	48.7	44.1	24.9	23.5	13.3
18	1.2	10.6	96.8	225.5	0.7	2.5	24.3	55.3	29.8	26.3	0.0
19	0.2	5.0	63.8	84.8	0.6	13.7	43.9	48.8	23.4	21.3	1.8
20	0.0	0.8	39.9	48.0	1.4	18.1	40.9	76.2	63.3	23.8	5.3
21	4.9	16.5	63.8	125.3	1.7	18.8	70.9	84.1	39.8	39.5	1.0
22	9.3	6.8	81.6	59.7	0.7	6.8	65.9	71.2	48.0	28.9	1.8
23	0.0	1.6	64.1	67.2	1.3	14.7	73.6	107.4	17.6	16.9	0.0
24	1.4	6.4	61.0	210.4	7.7	4.5	36.0	73.0	24.0	59.5	35.0
25	1.2	1.0	97.5	117.8	2.0	23.9	41.0	68.8	48.0	23.4	26.3
26	0.0	0.4	15.9	38.9	3.4	15.1	61.8	55.3	69.3	12.9	25.5
27	0.5	2.3	18.5	52.8	1.1	10.3	42.9	100.8	41.8	7.7	0.7
28	5.2	21.9	86.3	89.9	0.6	3.8	18.9	52.5	8.6	12.2	10.5
29	3.3	11.6	26.7	60.3	0.6	5.7	70.5	58.4	45.4	33.8	0.0
30	0.8	6.7	50.1	106.6	3.0	28.0	38.2	41.0	20.5	11.1	13.3
31	0.0	2.3	18.5	47.1	1.4	3.1	91.5	111.6	69.4	31.9	35.0
32	0.2	0.9	23.6	60.0	1.7	6.9	83.0	96.0	69.4	89.3	7.0
33	0.0	0.0	27.8	72.8	1.1	7.8	34.3	64.4	34.3	45.9	1.0
34	4.5	22.0	89.7	80.7	0.0	5.8	18.1	63.6	48.8	9.1	0.0
35	1.2	3.0	65.6	108.2	2.3	18.8	48.6	38.6	18.7	39.4	3.5
36	1.0	0.7	27.9	43.1	1.4	20.5	41.7	54.4	65.6	18.2	7.3
37	0.0	0.6	19.0	77.4	0.6	19.0	55.5	51.8	22.2	20.0	3.5
38	0.0	1.7	46.4	33.2	0.0	5.1	40.0	66.9	34.5	11.9	0.0
39	0.0	0.9	22.3	32.0	2.7	8.8	36.8	87.7	30.4	9.2	8.1
40	5.9	17.2	109.5	113.1	1.3	16.0	42.8	112.5	22.3	25.4	5.4

ROSEMAUND 1994: AREA UNDER DISEASE PROGRESS CURVE: BROWN RUST											
TREAT	LEAF 1	LEAF 2	LEAF 3	LEAF 4	LEAF 5	LEAF 6	LEAF 7	LEAF 8	LEAF 9	LEAF 1	LEAF 1
1	1.5	1.8	0.1	0.0	0.0	0.3	0.3	0.2	0.3	0.6	0.0
2	0.6	9.8	4.0	0.0	0.0	0.1	0.2	0.4	0.3	0.0	0.0
3	0.4	6.4	0.0	0.0	0.0	0.1	0.7	4.7	2.2	0.9	0.0
4	0.2	2.4	2.0	0.0	0.0	1.2	0.6	0.1	0.2	0.3	0.0
5	0.8	0.8	0.0	0.0	0.0	0.1	0.2	0.6	0.3	0.0	0.0
6	0.0	0.8	1.1	0.0	0.7	0.1	0.4	0.2	0.0	0.4	0.0
7	0.4	1.0	0.0	0.0	0.0	0.5	0.1	0.2	0.9	0.0	0.0
8	0.2	1.4	0.5	0.0	0.1	0.2	0.5	0.4	0.2	1.1	0.0
9	0.2	0.8	0.2	0.0	0.0	0.1	0.4	0.5	0.2	0.0	0.0
10	0.0	0.6	0.2	0.0	0.0	0.1	0.9	1.0	1.3	0.0	0.0
11	0.4	0.8	0.4	0.0	0.1	0.0	0.1	0.1	0.1	0.3	0.0
12	0.4	0.6	0.1	0.0	0.0	0.0	2.2	0.1	0.1	0.5	0.0
13	0.0	0.6	0.1	0.0	0.1	0.0	0.2	0.2	0.4	1.0	0.0
14	0.6	78.6	0.1	0.5	0.0	0.0	0.8	0.1	0.2	0.0	0.0
15	1.7	18.0	3.0	0.0	0.0	2.5	0.1	0.2	6.2	0.0	0.1
16	0.4	0.8	0.4	0.0	0.0	0.0	0.1	0.2	0.1	0.0	0.0
17	0.6	6.1	0.8	0.0	0.0	0.0	0.2	1.5	0.1	0.1	0.0
18	0.0	0.4	0.0	0.0	0.0	0.1	1.5	0.1	0.1	0.0	0.0
19	0.4	2.6	0.4	0.0	0.0	0.0	0.2	0.1	0.3	10.0	0.0
20	0.6	1.0	0.4	0.0	0.1	0.1	0.1	0.3	0.3	0.3	0.0
21	0.6	1.2	0.0	0.0	0.0	0.0	0.1	0.2	2.9	0.3	0.0
22	0.2	1.0	0.0	0.0	0.0	0.2	1.3	0.1	0.5	0.1	0.2
23	0.2	1.3	0.0	0.0	0.0	0.1	0.0	0.0	0.3	0.5	0.0
24	0.0	0.6	0.6	0.0	0.0	0.1	0.1	0.1	0.1	0.5	0.0
25	0.2	0.6	0.8	0.0	0.0	0.0	0.2	0.0	0.1	0.0	0.0
26	0.4	2.1	0.2	0.1	0.0	0.0	0.0	0.2	0.2	0.0	0.0
27	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.5	0.0
28	1.0	10.8	0.0	0.0	0.0	0.1	0.1	0.3	0.0	0.0	0.0
29	0.2	4.8	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0
30	0.2	1.5	12.9	0.0	0.0	0.1	0.1	0.1	0.2	0.1	0.1
31	0.2	0.6	0.0	0.0	0.1	0.3	0.0	0.2	0.3	0.6	0.2
32	0.0	0.6	0.4	0.0	0.0	0.1	0.0	0.1	2.8	0.0	0.0
33	0.0	1.2	1.7	0.0	0.0	0.0	0.1	0.2	0.0	0.0	0.0
34	0.8	1.4	3.6	0.0	0.0	0.1	0.1	0.1	0.4	5.6	0.0
35	0.6	4.1	0.2	0.0	0.0	0.0	0.1	0.1	0.2	0.0	0.0
36	0.4	2.5	0.9	0.0	0.1	0.0	0.1	0.6	4.7	0.0	0.0
37	0.2	0.4	0.4	0.0	0.0	0.0	1.5	0.0	1.6	0.2	0.0
38	0.2	0.2	0.0	0.0	0.0	0.0	0.1	0.1	0.7	0.1	0.3
39	0.2	0.4	0.4	0.0	0.0	0.0	0.1	0.1	0.2	7.7	0.0
40	1.5	2.2	3.7	0.0	0.0	0.4	1.7	0.4	0.1	0.2	0.2

ROSEMAUND 1994: AREA UNDER DISEASE PROGRESS CURVE: NET BLOTCH											
TREAT	LEAF 1	LEAF 2	LEAF 3	LEAF 4	LEAF 5	LEAF 6	LEAF 7	LEAF 8	LEAF 9	LEAF 1	LEAF 1
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.2	3.7	9.6	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	5.0	0.9	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.5	10.0	5.7	12.9	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.6	13.5	1.9	4.3	0.0
5	0.0	0.0	0.0	0.0	0.0	0.6	0.0	12.5	10.1	15.2	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.4	17.3	0.9	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	7.7	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.5	3.5	3.8	0.9	3.5
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	5.9	22.1	17.5
10	0.0	0.0	0.0	0.0	0.0	0.0	0.9	2.0	1.3	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.5	3.9	4.4	28.9	7.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.5	1.9	1.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.5	2.0	15.9	0.7	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	1.5	5.0	4.1	0.3	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.9	5.4	8.3	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	4.0	7.2	11.4	2.8	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.3	4.1	6.8	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	7.8	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	1.4	1.8	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	4.9	5.1	1.8
21	0.0	0.0	0.0	0.0	0.0	0.0	2.0	10.0	5.8	1.9	2.1
22	0.0	0.0	0.0	0.0	0.0	0.0	4.2	3.2	9.4	6.8	5.3
23	0.0	0.0	0.0	0.0	0.0	0.0	2.0	5.0	4.4	4.2	0.0
24	0.0	0.0	0.0	0.0	0.0	0.6	0.6	2.5	9.6	1.8	0.0
25	0.0	0.0	0.0	0.0	0.0	0.4	0.0	5.3	18.5	12.4	1.0
26	0.0	0.0	0.0	0.0	0.0	0.0	0.5	4.3	11.4	2.1	0.0
27	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	2.3	0.0	0.0
28	0.0	0.0	0.0	0.0	0.0	0.0	2.0	2.4	2.4	2.5	17.5
29	0.0	0.0	0.0	0.0	0.0	0.0	2.3	9.0	2.7	0.0	0.0
30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.2	7.1	14.4	0.0
31	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	6.4	0.0	0.0
32	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.7	0.0	0.0
33	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.0	4.9	3.4	0.0
34	0.0	0.0	0.0	0.0	0.6	0.6	1.0	2.0	6.0	0.3	0.0
35	0.0	0.0	0.0	0.0	0.0	0.6	0.5	3.0	5.7	2.9	0.0
36	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0	3.3	1.0	1.0
37	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	3.3	5.3	10.5
38	0.0	0.0	0.0	0.0	0.0	0.0	0.4	4.0	14.5	0.0	0.0
39	0.0	0.0	0.0	0.0	0.0	0.0	0.5	3.5	16.0	3.3	7.0
40	0.0	0.0	0.0	0.0	0.0	0.0	1.9	7.1	5.7	12.8	0.0

ABERDEEN 1995: AREA UNDER DISEASE PROGRESS CURVE: RHYNCHOSPORIUM								
TREAT	LEAF 1	LEAF 2	LEAF 3	LEAF 4	LEAF 5	LEAF 6	LEAF 7	LEAF 8
1	6.5	20.3	22.8	23.8	21.9	46.1	91.8	28.5
2	4.0	28.3	26.7	19.0	60.5	53.5	102.0	72.3
3	7.5	8.3	30.9	18.1	23.9	39.7	95.6	43.9
4	3.5	23.3	24.2	2.6	33.9	28.9	64.5	43.4
5	2.0	6.0	51.4	22.9	35.8	79.2	43.3	52.4
6	1.0	21.5	37.4	27.4	31.4	52.5	44.7	35.2
7	9.3	16.5	10.1	58.9	22.6	37.5	70.8	65.7
8	0.0	13.3	17.1	83.7	44.3	9.8	81.3	43.0
9	0.0	23.8	30.7	25.4	3.7	79.8	49.8	22.0
10	1.5	23.9	31.8	39.6	72.9	28.7	64.4	5.4
11	0.0	10.5	21.1	43.1	16.0	108.3	68.4	24.4
12	2.3	7.0	18.2	16.0	11.6	5.4	56.5	22.0
13	2.0	5.3	31.8	34.8	16.4	97.6	143.5	76.3
14	1.0	8.8	12.4	21.8	49.9	45.1	141.4	2.8
15	5.8	6.3	8.3	13.5	0.0	14.8	76.9	22.5
16	0.0	9.5	4.1	9.2	39.6	24.4	103.0	33.9
17	6.8	9.0	16.8	16.6	35.5	35.8	107.2	34.1
18	0.0	6.0	12.6	0.0	46.0	43.5	51.6	13.0
19	0.0	13.8	38.6	59.0	29.7	17.0	67.9	42.8
20	0.0	16.3	28.3	3.5	55.2	8.0	36.3	53.4
21	0.0	6.0	10.4	30.0	16.5	10.8	33.8	90.5
22	0.0	5.8	10.3	19.8	31.1	17.1	129.0	31.8
23	13.8	18.7	37.7	17.8	55.0	89.9	100.5	70.7
24	4.3	12.5	10.6	25.6	81.9	85.9	108.3	73.3
25	1.5	12.1	26.7	49.3	49.8	45.2	30.7	24.8
26	0.0	7.3	20.0	25.8	23.7	16.1	68.3	48.6
27	2.3	8.3	8.5	4.4	7.0	55.2	105.1	47.3
28	0.0	12.8	43.6	9.5	29.6	39.4	77.6	52.5
29	0.0	8.5	21.8	9.4	64.7	59.6	98.5	16.3
30	12.0	27.6	36.2	24.2	64.1	27.8	102.2	9.8
31	2.5	15.8	16.6	17.4	69.4	40.3	54.5	19.3
32	0.0	13.5	41.7	31.2	36.8	40.6	99.7	11.0
33	0.8	2.8	4.2	19.9	32.6	38.4	135.8	29.5
34	0.0	3.5	13.9	20.2	28.5	38.3	46.0	20.8
35	3.8	14.0	13.8	28.9	4.9	22.3	69.0	59.3
36	0.0	4.5	6.5	29.1	16.5	46.7	30.5	38.5
37	0.3	7.0	33.7	27.0	6.7	42.6	37.9	85.9
38	1.3	18.5	20.2	17.2	23.6	44.9	140.8	74.0
39	0.8	4.3	11.1	29.1	14.3	7.9	38.7	30.3
40	1.7	6.9	14.4	27.5	12.4	33.2	41.7	39.2

ABERDEEN 1995: AREA UNDER DISEASE PROGRESS CURVE: MILDEW								
TREAT	LEAF 1	LEAF 2	LEAF 3	LEAF 4	LEAF 5	LEAF 6	LEAF 7	LEAF 8
1	399.8	1555.7	1826.3	553.7	1073.9	406.1	322.5	126.4
2	343.6	1377.7	2144.1	475.3	734.7	828.2	287.6	120.8
3	238.1	1120.6	1624.5	577.9	526.2	433.5	339.6	46.1
4	300.0	1173.3	1210.0	376.2	218.0	363.6	285.5	90.0
5	159.0	795.9	1273.4	210.2	378.2	525.6	380.3	208.8
6	187.8	819.5	1111.2	120.5	359.9	407.1	390.7	103.6
7	233.0	1108.0	2231.7	1036.7	640.9	583.3	377.1	98.1
8	143.5	965.6	1801.4	904.6	999.4	224.3	239.3	111.4
9	116.8	1008.7	1787.2	838.3	240.4	450.3	275.5	113.8
10	58.5	678.4	1686.9	435.4	427.3	777.3	275.3	10.8
11	88.0	488.5	1255.7	459.3	494.2	413.8	246.2	15.4
12	76.0	449.3	745.7	177.4	321.3	588.0	398.3	55.0
13	79.8	560.9	926.3	244.8	602.7	584.9	429.2	75.8
14	39.3	388.0	557.2	236.1	409.3	438.2	281.8	77.8
15	353.0	1481.7	1575.5	458.5	266.7	103.4	218.4	76.4
16	210.3	1053.4	1136.2	228.1	423.9	309.9	333.3	48.2
17	133.3	793.0	909.6	159.0	278.9	172.1	152.3	47.8
18	167.5	911.9	1539.5	512.1	310.5	241.7	328.2	30.1
19	57.8	572.8	1236.3	689.6	606.0	359.6	153.6	34.0
20	58.8	361.2	540.8	189.4	327.2	246.0	142.7	56.4
21	21.9	293.0	809.7	197.5	368.0	202.3	179.8	74.6
22	38.5	319.8	665.2	222.0	303.4	393.2	244.0	33.5
23	346.3	1305.6	1983.8	268.4	201.5	124.5	149.5	79.6
24	171.3	820.6	1292.3	176.4	213.4	216.4	198.5	33.0
25	172.0	843.1	1457.6	488.7	344.6	208.7	167.1	82.6
26	82.5	418.4	792.2	99.9	180.9	134.7	159.9	22.8
27	43.5	493.4	899.3	174.7	281.1	155.9	199.5	69.0
28	47.3	349.9	446.8	124.1	298.7	249.6	208.4	112.7
29	40.0	380.0	594.5	179.4	319.3	277.6	178.6	11.0
30	342.6	1212.2	1926.1	843.8	464.5	181.3	174.4	91.2
31	293.4	1235.7	1536.0	261.9	334.7	273.9	241.3	80.8
32	248.0	1169.0	1608.9	572.9	491.4	193.3	272.2	23.0
33	86.6	636.0	762.0	193.1	336.8	113.4	175.5	38.9
34	58.8	410.9	904.3	140.1	209.7	103.5	154.5	53.8
35	291.3	1446.5	1590.0	271.1	222.5	280.3	197.3	66.0
36	127.0	655.0	582.4	151.6	208.6	143.3	155.1	82.1
37	36.3	522.6	1293.5	285.8	276.8	239.2	177.1	109.1
38	151.0	637.9	1147.0	122.3	158.8	140.2	193.6	109.9
39	53.0	329.9	514.6	177.9	221.2	129.8	160.5	57.8
40	62.7	440.0	882.8	236.7	483.2	326.4	221.1	59.9

ABERDEEN 1995: AREA UNDER DISEASE PROGRESS CURVE: BROWN RUST								
TREAT	LEAF 1	LEAF 2	LEAF 3	LEAF 4	LEAF 5	LEAF 6	LEAF 7	LEAF 8
1	36.0	70.4	31.2	15.3	8.6	16.8	29.8	16.5
2	37.5	68.8	49.8	19.0	23.8	39.7	42.8	17.0
3	27.5	64.2	30.0	7.3	13.9	24.5	36.7	14.3
4	26.0	44.7	43.0	25.5	5.9	9.4	28.1	31.5
5	20.5	37.0	35.7	15.5	6.7	16.5	47.0	38.1
6	20.0	40.9	36.6	4.2	17.3	9.7	20.8	15.8
7	34.5	61.8	77.0	20.5	8.1	21.5	30.7	24.9
8	31.8	84.2	39.4	29.7	8.1	13.4	28.5	5.5
9	23.8	73.2	43.3	14.8	3.3	6.8	34.8	38.5
10	16.3	61.1	28.0	14.2	15.8	22.3	39.9	0.0
11	10.8	35.6	74.6	24.7	11.9	10.0	30.2	0.0
12	12.8	27.5	52.1	10.8	14.4	13.4	60.6	11.0
13	19.0	49.0	59.7	6.4	15.4	11.6	45.7	17.6
14	9.5	28.1	41.6	4.3	8.5	18.8	14.8	32.1
15	32.3	37.8	23.5	5.3	6.5	3.1	20.1	12.7
16	23.0	40.0	28.1	4.1	8.4	43.4	24.5	17.6
17	13.8	37.8	30.2	6.5	6.3	3.2	11.6	8.8
18	16.3	46.4	23.4	10.6	5.7	7.8	34.2	8.8
19	12.8	39.0	21.8	10.8	11.7	20.5	18.3	2.8
20	15.3	26.0	32.6	5.9	4.7	5.4	14.1	7.3
21	8.8	17.3	35.0	5.2	5.6	15.1	19.0	14.7
22	6.3	19.8	24.5	3.0	2.6	32.0	24.4	2.8
23	31.5	42.5	24.7	0.7	9.6	1.4	11.4	21.1
24	17.5	39.4	51.0	3.4	3.7	13.6	21.2	12.8
25	20.0	48.3	38.4	18.1	7.6	5.5	17.2	5.5
26	11.5	29.1	18.1	3.3	1.7	7.5	15.7	15.3
27	7.5	24.3	36.0	3.8	1.6	9.5	15.3	7.7
28	10.3	18.0	19.6	0.0	0.5	7.3	12.6	5.5
29	9.0	21.8	38.8	0.7	0.5	8.1	18.7	6.5
30	28.5	47.7	22.8	14.5	0.0	4.4	10.0	0.0
31	23.0	41.4	43.7	14.1	23.8	14.6	21.7	18.6
32	19.0	40.6	18.8	7.8	7.9	4.9	17.7	15.4
33	10.0	35.1	71.5	1.9	6.1	7.7	14.8	8.8
34	12.5	32.0	32.1	2.8	4.0	5.1	6.4	4.4
35	15.3	31.5	22.6	13.3	1.6	1.8	10.3	14.7
36	14.8	31.8	50.1	4.2	4.2	4.4	15.2	8.9
37	8.5	40.0	58.9	7.1	4.9	11.9	9.5	18.3
38	14.8	41.4	61.8	5.9	4.7	6.2	27.8	11.4
39	10.3	20.5	34.7	0.0	4.3	2.0	12.4	2.8
40	15.0	39.4	51.8	23.9	11.4	14.2	30.8	20.9

ABERDEEN 1995: AREA UNDER DISEASE PROGRESS CURVE: NET BLOTCH								
TREAT	LEAF 1	LEAF 2	LEAF 3	LEAF 4	LEAF 5	LEAF 6	LEAF 7	LEAF 8
1	3.0	7.1	1.3	0.0	0.0	0.0	0.0	0.0
2	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	3.7	0.0	0.0	0.0	0.0
4	2.6	1.7	1.6	0.0	0.7	0.0	0.0	0.0
5	1.8	0.0	2.6	0.0	0.0	0.0	0.0	0.0
6	1.8	5.5	0.0	0.0	0.0	0.0	0.0	0.0
7	4.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	4.8	0.0	1.6	0.0	0.0	0.0	0.0
10	0.0	1.8	0.0	2.9	0.0	0.0	0.0	0.0
11	2.5	2.3	0.0	0.0	0.0	0.0	0.0	0.0
12	1.8	0.8	0.0	0.0	0.0	0.0	0.0	0.0
13	1.3	3.5	5.1	0.0	0.0	0.0	0.0	0.0
14	1.5	4.3	7.6	0.5	0.0	0.0	0.0	0.0
15	0.8	2.8	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0
17	0.8	0.0	3.9	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	2.3	1.3	0.0	0.0	0.0	0.0	0.0
20	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	3.3	3.3	0.0	0.0	0.0	0.0	0.0
22	0.8	3.0	7.2	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	7.5	0.0	0.0	0.0	0.0	0.0
24	5.5	9.7	1.3	3.3	0.0	0.0	0.0	0.0
25	3.5	1.0	0.0	0.0	0.0	0.0	0.0	0.0
26	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0
27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
28	1.3	3.8	0.0	0.0	0.0	0.0	0.0	0.0
29	0.8	3.5	1.3	1.3	0.0	0.0	0.0	0.0
30	5.8	2.5	1.1	1.6	0.0	0.0	0.0	0.0
31	0.0	0.8	7.5	2.2	0.0	0.0	0.0	0.0
32	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
33	0.0	1.0	2.0	0.0	0.0	0.0	0.0	0.0
34	0.0	1.3	4.6	1.6	0.0	0.0	0.0	0.0
35	3.5	5.6	0.0	0.0	0.0	0.0	0.0	0.0
36	2.5	0.0	0.0	2.1	0.0	0.0	0.0	0.0
37	0.8	6.8	0.0	3.2	0.0	0.0	0.0	0.0
38	0.0	1.5	0.0	3.7	3.0	0.0	0.0	0.0
39	3.8	0.8	4.5	0.0	0.0	0.0	0.0	0.0
40	0.0	1.8	0.0	0.0	0.0	0.0	4.2	0.0

MORLEY 1995: AREA UNDER DISEASE PROGRESS CURVE: RHYNCHOSPORIUM								
TREAT	LEAF 1	LEAF 2	LEAF 3	LEAF 4	LEAF 5	LEAF 6	LEAF 7	
1	0.0	0.0	0.0	0.0	0.0	0.7	1.4	
2	0.0	5.8	0.3	0.0	0.0	0.0	0.5	
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
4	0.0	0.0	0.0	0.0	0.0	0.0	0.4	
5	0.0	0.0	0.0	0.0	0.0	0.4	1.5	
6	0.0	0.0	2.4	0.0	0.0	0.0	0.0	
7	0.0	1.6	6.3	0.0	0.0	0.0	0.0	
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
9	0.0	0.0	3.1	0.0	0.0	0.0	3.0	
10	0.0	2.5	0.0	0.0	0.0	1.5	0.8	
11	0.0	1.5	0.3	1.1	0.0	0.8	0.0	
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
13	0.1	4.3	1.3	0.0	0.0	0.4	0.2	
14	1.0	1.1	2.0	0.0	0.0	0.0	1.5	
15	0.0	0.0	5.8	5.6	0.0	3.8	0.4	
16	0.0	0.0	1.3	0.0	0.0	0.0	0.0	
17	0.0	0.0	0.0	0.8	0.0	0.0	1.7	
18	0.0	0.0	0.1	0.0	0.0	0.0	0.0	
19	0.0	0.0	0.0	0.0	0.0	1.4	4.5	
20	0.0	0.0	2.5	0.0	0.0	0.2	6.0	
21	0.0	0.0	0.3	0.0	0.1	0.4	1.5	
22	2.5	0.0	0.0	0.0	0.0	0.4	0.4	
23	0.0	4.0	0.3	0.0	0.0	0.8	2.4	
24	0.0	0.0	0.0	0.0	0.0	0.2	4.5	
25	0.0	2.5	0.0	1.9	0.0	0.0	0.0	
26	0.0	0.5	4.1	3.8	0.0	2.3	8.4	
27	0.0	2.0	0.0	0.0	0.0	0.0	0.0	
28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
29	0.0	0.0	0.0	0.0	0.0	4.1	3.9	
30	0.0	1.0	0.0	0.5	0.0	0.0	0.4	
31	0.0	2.5	0.0	1.0	0.0	0.0	0.0	
32	0.0	0.0	1.0	0.0	0.0	0.0	8.3	
33	0.0	0.0	3.5	2.7	0.0	0.1	0.8	
34	0.0	0.0	0.6	3.7	0.0	0.2	1.5	
35	0.0	0.0	0.0	0.0	0.0	0.0	2.3	
36	0.2	0.0	0.0	0.4	0.0	0.0	2.4	
37	0.0	0.0	0.3	0.0	0.0	3.4	0.1	
38	0.0	0.9	0.0	0.0	0.0	0.0	0.8	
39	0.0	0.0	0.0	0.0	0.0	0.0	3.0	
40	0.0	0.2	2.6	0.0	0.0	0.3	0.0	
41	0.0	0.6	0.0	0.0	0.0	0.0	0.1	

MORLEY 1995: AREA UNDER DISEASE PROGRESS CURVE: MILDEW							
TREAT	LEAF 1	LEAF 2	LEAF 3	LEAF 4	LEAF 5	LEAF 6	LEAF 7
1	0.0	2.5	2.8	0.0	0.9	3.7	15.8
2	0.0	0.7	0.4	0.1	0.8	11.4	38.2
3	0.0	1.5	0.5	0.2	0.4	9.9	16.5
4	0.0	4.3	0.0	0.3	0.4	11.0	28.7
5	0.0	2.5	0.5	0.4	0.7	8.2	14.1
6	0.4	0.8	0.0	0.0	0.0	8.1	18.8
7	0.0	0.6	1.3	0.6	0.2	7.7	16.2
8	0.0	0.9	0.6	0.1	0.1	8.7	26.0
9	0.0	0.0	0.0	0.0	0.0	4.4	16.0
10	0.3	1.3	0.0	3.8	0.1	10.8	18.4
11	0.0	1.3	1.0	4.4	0.5	9.1	20.1
12	0.4	0.0	0.4	0.1	0.0	12.5	26.6
13	0.4	0.4	0.1	0.5	0.8	15.2	43.1
14	0.2	0.7	0.1	0.0	0.5	11.6	18.8
15	0.2	0.6	2.4	0.3	0.1	13.1	16.2
16	0.4	1.1	0.8	0.0	0.0	4.9	17.6
17	0.0	0.3	0.1	0.3	0.0	6.9	18.8
18	0.0	0.7	0.1	0.5	0.0	10.6	20.6
19	0.2	2.8	3.6	0.1	0.0	4.8	15.0
20	0.0	0.5	0.0	0.1	0.0	6.1	10.6
21	0.0	0.5	0.0	1.1	0.0	12.9	37.8
22	0.0	0.2	0.1	0.4	0.0	10.4	24.5
23	0.4	0.3	0.7	0.6	0.1	7.2	25.9
24	0.0	1.5	0.3	0.8	0.0	6.9	15.6
25	0.0	0.4	0.7	0.1	0.0	7.6	19.1
26	0.0	0.4	0.0	1.1	0.0	4.7	16.5
27	0.0	0.2	0.0	0.2	0.0	3.9	13.3
28	0.0	0.2	0.0	0.5	0.0	8.4	23.6
29	0.0	1.5	0.0	0.2	0.4	2.8	11.6
30	0.0	1.4	0.3	0.8	0.0	18.6	29.7
31	0.2	1.6	0.6	0.1	0.0	5.9	18.9
32	0.2	3.0	1.2	0.1	0.0	10.6	33.3
33	0.2	0.0	0.0	1.4	0.0	6.1	17.6
34	0.0	0.5	0.1	0.1	0.0	12.4	22.6
35	0.0	3.4	0.1	0.1	0.0	9.5	18.4
36	0.0	1.1	0.1	0.1	0.0	7.8	17.8
37	0.0	0.0	0.1	0.1	0.0	4.9	12.8
38	0.0	0.3	0.1	0.1	0.0	6.2	20.4
39	0.2	0.0	0.0	1.5	0.0	6.8	23.8
40	0.0	1.6	0.0	1.4	0.5	14.9	27.5
41	0.2	0.7	0.0	0.3	0.6	7.6	23.5

MORLEY 1995: AREA UNDER DISEASE PROGRESS CURVE: BROWN RUST							
TREAT	LEAF 1	LEAF 2	LEAF 3	LEAF 4	LEAF 5	LEAF 6	LEAF 7
1	212.1	703.9	1004.6	72.6	4.2	26.7	12.6
2	315.1	709.8	876.5	69.8	4.7	20.4	19.5
3	123.0	307.6	256.5	65.4	2.2	20.9	21.0
4	142.8	309.2	198.8	60.7	5.2	25.6	13.9
5	194.3	325.6	181.0	74.6	4.0	40.6	25.8
6	154.3	200.7	81.6	47.7	3.8	20.3	12.5
7	194.8	523.3	915.2	81.6	1.2	21.6	10.5
8	225.6	698.8	914.2	92.6	4.8	34.7	11.3
9	75.0	485.9	633.1	59.1	2.3	22.6	11.9
10	107.6	384.0	489.3	147.9	1.2	29.3	11.9
11	36.5	119.1	159.9	72.2	3.5	33.2	20.4
12	52.5	120.8	70.9	28.7	3.9	32.0	11.9
13	79.4	137.0	83.5	33.8	3.1	16.4	13.7
14	24.2	52.2	28.3	57.8	3.4	27.9	11.7
15	132.6	395.6	658.0	29.3	1.9	8.3	10.0
16	107.1	146.2	71.2	11.1	2.3	12.3	5.3
17	41.8	114.4	72.9	20.8	1.4	18.5	13.7
18	74.4	151.1	112.9	59.5	1.7	19.4	10.4
19	71.9	205.9	254.0	24.2	1.4	8.9	5.4
20	33.1	63.8	35.2	37.9	0.5	8.1	6.6
21	12.9	61.7	55.6	21.5	3.0	15.8	8.8
22	12.4	31.6	12.4	21.0	2.4	9.6	6.3
23	259.8	519.3	601.0	48.9	1.7	3.0	6.7
24	162.8	228.9	89.5	26.6	0.9	7.3	6.4
25	75.6	189.1	229.4	40.9	0.7	4.0	5.7
26	29.9	56.7	15.8	10.2	0.5	2.5	10.5
27	23.9	51.3	13.6	7.4	1.2	3.5	6.7
28	33.4	42.2	10.8	11.4	1.6	4.0	6.8
29	7.7	18.6	5.1	6.9	1.2	4.0	3.6
30	243.7	400.4	403.0	13.3	2.9	1.6	4.7
31	148.4	244.4	201.5	39.1	0.4	1.8	5.0
32	151.0	328.9	370.5	408.5	0.8	2.0	3.8
33	29.5	37.3	20.4	7.0	1.0	1.9	8.4
34	21.0	49.0	22.3	8.1	1.0	2.3	7.0
35	165.9	323.8	391.6	23.5	0.7	0.7	4.7
36	34.4	52.4	9.4	5.8	0.5	1.5	2.9
37	14.0	29.1	14.6	12.1	0.2	2.0	4.5
38	26.8	65.9	43.2	6.5	0.8	1.0	2.5
39	17.6	32.3	17.7	6.1	0.1	1.4	6.5
40	67.2	127.7	52.8	26.2	1.5	13.4	8.1
41	38.6	104.1	50.1	16.5	3.0	10.6	8.7

MORLEY 1995: AREA UNDER DISEASE PROGRESS CURVE:NET BLOTCH							
TREAT	LEAF 1	LEAF 2	LEAF 3	LEAF 4	LEAF 5	LEAF 6	LEAF 7
1	0.0	4.9	22.9	0.0	0.2	1.7	5.7
2	0.0	5.6	11.5	3.2	0.0	2.2	8.5
3	2.3	15.0	15.9	5.1	0.1	0.9	1.9
4	4.1	22.4	44.3	2.6	0.8	3.1	1.5
5	5.6	26.7	35.1	2.1	0.7	2.7	2.9
6	2.1	30.3	44.2	1.4	0.5	1.9	5.5
7	0.3	25.8	13.8	2.9	0.5	1.5	3.0
8	5.3	23.3	6.4	0.6	0.4	0.9	6.8
9	1.2	8.9	22.6	1.8	0.7	1.2	2.6
10	3.5	17.2	22.8	2.5	0.5	0.9	4.7
11	6.9	30.3	36.2	8.8	0.0	2.3	2.3
12	7.9	28.7	23.6	2.3	0.4	1.7	7.1
13	7.0	21.0	21.3	0.7	0.0	1.9	3.5
14	13.0	31.2	34.8	1.0	0.0	2.2	7.1
15	3.7	24.6	22.2	7.4	0.9	2.1	10.2
16	13.8	31.6	28.5	11.8	0.4	0.6	4.1
17	6.9	22.9	26.6	5.7	0.0	2.2	2.7
18	6.3	24.9	27.8	5.4	0.1	2.5	6.8
19	11.5	14.1	18.1	3.8	0.0	0.6	2.3
20	2.9	38.0	27.7	11.9	0.4	0.2	8.7
21	5.1	22.4	23.0	5.0	0.1	0.6	2.1
22	7.7	40.1	60.6	2.4	0.4	1.5	7.9
23	11.3	26.2	8.1	3.8	0.0	0.7	2.6
24	9.8	59.5	23.5	15.1	0.0	0.3	1.1
25	8.8	14.7	32.7	17.0	0.7	2.7	4.2
26	7.4	30.5	42.0	5.2	0.1	1.2	1.7
27	12.9	25.0	48.7	16.8	0.7	1.8	2.0
28	7.9	24.7	53.7	1.9	0.0	2.1	6.9
29	1.2	30.3	38.1	5.9	0.9	3.4	4.2
30	14.1	25.0	10.0	7.8	0.4	3.5	4.0
31	5.3	43.0	22.4	13.1	0.7	1.1	3.8
32	13.7	19.6	26.4	6.7	2.3	3.9	3.8
33	20.8	27.0	48.8	4.3	0.4	2.0	6.2
34	5.2	27.2	40.9	9.0	0.5	3.4	4.4
35	7.6	21.6	15.4	9.3	0.4	2.1	13.2
36	7.7	27.6	34.7	6.2	0.7	1.5	4.8
37	3.1	28.1	30.0	20.8	0.1	2.2	2.5
38	7.6	20.0	26.1	13.7	0.0	0.7	9.9
39	4.2	47.5	32.1	19.2	0.0	3.0	3.0
40	9.6	28.1	34.4	14.9	0.7	1.9	7.5
41	2.0	14.2	26.0	6.1	0.2	1.7	1.9

ROSEMAUND 1995: AREA UNDER DISEASE PROGRESS CURVE: RHYNCHOSPORIUM										
TREAT	LEAF 1	LEAF 2	LEAF 3	LEAF 4	LEAF 5	LEAF 6	LEAF 7	LEAF 8	LEAF 9	LEAF 10
1	6.0	7.5	20.2	50.9	22.1	17.3	38.5	52.4	1.0	1.8
2	0.0	3.9	13.5	15.2	13.1	16.3	34.6	45.0	0.0	0.6
3	0.5	5.1	14.3	16.3	15.2	13.1	49.4	55.6	20.8	0.0
4	6.6	11.7	13.5	14.2	13.7	22.1	55.7	64.0	1.1	0.0
5	2.5	8.3	20.9	6.3	11.0	8.9	48.3	37.4	0.7	3.4
6	0.5	3.6	22.7	21.0	16.8	14.2	51.7	71.9	41.3	56.3
7	1.8	4.9	15.8	20.5	17.3	19.4	58.1	58.0	1.8	1.5
8	1.3	6.2	3.7	10.5	14.2	11.0	45.2	47.9	6.8	3.4
9	0.0	6.6	6.3	5.3	14.2	12.1	58.3	71.5	0.9	4.5
10	0.5	5.3	7.6	6.8	18.4	15.2	48.3	51.9	1.1	0.0
11	0.8	11.1	21.7	22.6	5.8	16.8	34.7	38.4	1.6	0.0
12	0.0	6.5	8.1	5.3	6.8	12.6	32.0	25.2	1.4	0.0
13	0.5	6.0	20.0	4.2	10.0	15.0	34.0	70.8	1.4	6.8
14	0.5	1.8	13.3	22.1	10.0	12.6	40.4	52.3	11.3	1.5
15	1.3	10.4	13.7	44.1	19.4	7.9	29.9	45.3	0.5	6.8
16	8.5	6.9	9.9	3.7	6.3	4.7	27.2	54.1	1.6	0.0
17	0.0	8.5	11.0	19.4	6.8	4.7	40.3	113.1	1.6	0.0
18	1.8	7.1	7.9	7.4	6.8	4.2	24.7	34.0	0.2	3.8
19	0.0	1.5	13.5	7.4	5.8	9.5	33.6	67.0	0.0	0.0
20	1.0	6.0	21.9	4.7	7.9	7.9	36.2	58.6	7.5	2.3
21	2.1	0.0	6.8	8.9	4.2	3.2	77.2	32.9	0.7	0.0
22	0.5	1.3	8.3	10.0	6.8	7.4	39.4	77.5	5.2	0.7
23	1.5	3.9	10.5	11.0	32.6	15.2	30.5	52.8	0.3	0.0
24	0.3	3.3	8.8	9.5	11.6	17.9	31.5	52.7	2.3	0.0
25	3.5	6.9	19.1	8.9	11.0	5.3	34.7	45.2	0.5	0.7
26	0.3	3.4	4.6	5.3	4.7	6.3	30.4	30.7	1.0	0.0
27	0.8	3.5	18.9	7.9	11.6	12.1	46.7	49.7	0.0	4.5
28	2.5	2.4	6.8	3.7	2.6	7.4	24.1	27.3	8.3	11.3
29	1.5	5.7	6.2	12.6	16.8	9.5	25.1	46.1	0.5	1.1
30	1.5	2.3	2.6	25.2	23.1	5.8	31.5	66.5	3.9	0.0
31	1.8	6.4	9.4	17.9	7.4	12.6	34.6	48.5	1.6	3.2
32	2.5	3.6	10.5	8.9	11.6	4.2	18.4	34.9	2.0	0.0
33	13.1	5.1	12.6	7.4	3.2	1.6	22.5	41.3	1.0	3.2
34	1.0	2.1	1.6	4.2	2.1	3.7	37.8	49.2	2.1	0.0
35	8.0	16.3	22.5	20.5	4.7	2.6	25.2	32.6	1.4	0.0
36	8.2	3.6	2.6	12.6	6.3	6.8	25.7	68.6	7.7	0.0
37	1.3	3.4	12.5	7.9	3.7	7.6	35.2	64.8	2.8	0.0
38	2.3	2.8	4.8	11.0	5.3	11.6	21.0	101.0	2.0	2.3
39	1.0	3.4	7.9	14.2	6.8	4.7	30.1	51.3	0.7	1.6
40	0.4	4.5	12.3	6.0	6.7	12.3	36.0	47.3	2.3	0.5

ROSEMAUND 1995: AREA UNDER DISEASE PROGRESS CURVE: MILDEW											
TREAT	LEAF 1	LEAF 2	LEAF 3	LEAF 4	LEAF 5	LEAF 6	LEAF 7	LEAF 8	LEAF 9	LEAF 10	
1	4.6	12.4	48.1	63.5	50.4	11.6	42.5	79.7	37.4	16.9	
2	3.6	28.2	57.3	37.8	26.3	15.0	48.8	98.1	48.3	20.8	
3	0.0	2.4	4.2	3.2	10.0	5.8	36.1	87.4	26.8	8.4	
4	0.0	2.1	2.6	2.1	3.7	10.5	35.7	65.5	47.5	15.8	
5	1.0	1.6	2.6	5.3	22.6	7.4	42.5	100.9	24.0	41.6	
6	0.3	3.4	1.8	3.2	11.6	15.0	44.4	92.5	55.5	4.5	
7	1.0	4.7	16.5	26.3	17.3	7.6	38.7	79.0	14.9	8.3	
8	0.0	53.6	3.7	26.3	13.7	8.9	52.6	80.0	36.7	5.6	
9	0.0	5.9	9.9	14.2	7.4	6.3	39.9	87.8	92.3	22.5	
10	0.0	3.1	11.3	16.3	15.8	12.9	29.8	69.3	74.7	54.5	
11	0.3	4.2	6.6	8.9	22.6	30.5	54.2	122.2	39.3	0.0	
12	0.0	1.3	2.1	1.6	5.3	6.8	55.2	107.0	94.4	14.6	
13	0.5	2.6	1.1	1.6	6.8	10.0	50.4	86.2	16.2	30.4	
14	0.0	0.5	1.6	1.6	11.0	8.9	39.6	120.7	51.9	25.0	
15	0.0	1.8	12.1	5.8	3.7	3.2	28.6	70.3	17.3	33.8	
16	0.0	2.3	3.4	1.6	2.6	7.4	40.5	78.6	20.2	18.8	
17	0.8	2.1	0.0	1.1	4.2	9.2	36.4	101.5	11.2	9.0	
18	2.3	3.6	5.8	4.7	4.2	5.3	26.6	68.5	14.3	11.3	
19	0.0	6.7	10.2	14.2	8.4	3.7	57.9	70.0	23.3	11.3	
20	0.0	1.1	0.5	3.2	4.7	6.8	25.4	79.5	77.3	14.6	
21	0.0	1.6	1.8	4.2	4.2	8.9	39.0	111.7	16.9	10.1	
22	0.5	1.1	0.5	1.1	4.7	7.4	42.3	92.7	54.8	20.9	
23	2.3	9.8	14.5	12.6	2.1	3.2	41.7	103.0	21.5	10.6	
24	0.8	1.8	6.4	4.7	5.8	4.7	26.3	92.6	11.5	25.4	
25	0.5	4.7	5.5	8.4	7.9	7.9	38.7	68.0	17.0	8.3	
26	0.0	1.0	2.1	1.6	3.2	5.8	37.6	95.5	45.5	11.3	
27	0.0	1.1	1.8	1.6	4.2	9.0	49.2	88.3	85.8	15.8	
28	0.0	2.1	2.1	0.5	3.2	2.1	30.3	93.6	42.9	12.4	
29	0.0	0.5	0.5	1.6	4.7	2.4	29.9	80.6	18.4	14.6	
30	1.1	4.9	8.8	9.5	5.8	8.1	26.1	83.4	87.2	11.3	
31	0.8	3.4	2.1	2.1	4.7	1.6	21.5	52.4	24.0	41.0	
32	0.0	1.3	3.9	7.9	5.8	2.4	34.9	104.9	42.3	14.6	
33	0.3	2.3	54.3	3.2	5.8	6.8	35.4	81.0	117.1	11.7	
34	0.0	2.8	3.6	1.1	3.7	6.3	42.7	84.4	44.1	16.9	
35	0.5	2.6	6.0	10.0	6.3	7.4	31.2	84.6	31.8	0.0	
36	0.3	0.5	0.8	1.1	4.7	7.4	28.0	106.3	92.8	15.8	
37	0.0	2.4	2.1	2.6	9.5	14.2	47.3	82.1	35.1	15.8	
38	0.5	0.8	0.5	2.1	7.4	10.0	54.8	88.8	36.8	61.3	
39	0.0	1.6	2.6	2.6	2.6	3.4	29.5	68.5	15.1	27.0	
40	0.4	1.1	1.9	9.1	9.8	14.7	39.9	102.3	44.7	16.5	

ROSEMAUND 1995: AREA UNDER DISEASE PROGRESS CURVE: BROWN RUST											
TREAT	LEAF 1	LEAF 2	LEAF 3	LEAF 4	LEAF 5	LEAF 6	LEAF 7	LEAF 8	LEAF 9	LEAF 10	
1	8.9	35.9	74.1	102.9	74.6	18.9	8.4	3.6	0.0	0.0	
2	12.5	37.9	78.4	63.0	25.7	5.4	6.1	4.5	0.0	0.0	
3	4.3	11.7	19.5	7.9	3.2	2.7	0.4	2.9	0.3	0.1	
4	10.6	27.6	15.5	4.2	1.1	2.1	1.7	6.6	0.0	0.0	
5	5.6	11.8	21.2	1.6	2.1	1.6	0.8	9.3	0.0	0.0	
6	3.3	8.1	7.8	0.5	2.6	4.4	3.9	0.9	1.0	0.0	
7	10.6	32.2	67.0	46.2	29.4	9.5	5.0	1.2	0.1	0.0	
8	1.3	9.2	15.2	26.8	34.7	11.1	9.8	6.4	0.0	0.0	
9	2.3	6.9	10.3	22.6	18.4	13.1	7.2	9.8	5.0	0.0	
10	2.8	3.1	11.9	21.5	38.3	10.5	3.6	4.8	0.0	0.0	
11	2.3	7.7	6.8	11.0	6.8	0.6	2.1	6.9	0.0	0.0	
12	1.0	4.1	2.6	1.6	0.5	1.3	0.8	7.6	0.0	0.2	
13	4.8	9.7	7.6	1.1	1.6	0.1	1.4	6.6	0.0	0.0	
14	1.8	2.8	1.6	0.0	2.6	0.1	2.8	1.5	0.0	0.0	
15	3.1	7.9	25.9	17.3	6.3	1.1	0.0	1.2	0.0	0.0	
16	3.0	7.9	3.6	0.0	1.1	0.0	1.4	3.3	0.0	0.0	
17	3.3	5.1	11.0	1.1	3.2	0.1	0.6	2.4	0.0	0.0	
18	3.0	8.9	5.1	3.7	0.0	0.0	0.0	1.9	0.0	0.0	
19	3.5	8.7	5.4	7.9	5.8	1.6	0.8	0.2	0.0	0.0	
20	3.0	6.6	3.5	0.0	0.5	0.0	0.2	1.0	0.1	0.0	
21	1.3	2.0	1.8	1.1	1.6	0.5	0.2	1.1	0.0	0.0	
22	1.0	1.5	0.8	0.0	0.5	0.0	0.2	2.8	0.0	0.0	
23	5.5	17.3	36.3	23.6	2.6	0.5	0.1	1.8	0.1	0.3	
24	8.4	23.4	35.0	2.6	1.1	0.0	1.1	1.5	0.0	0.0	
25	5.0	9.4	12.6	17.9	2.6	0.0	1.7	0.4	0.0	0.0	
26	2.3	4.0	4.4	1.1	1.1	0.0	0.1	0.4	2.5	0.5	
27	3.0	7.4	2.0	0.0	0.5	1.7	0.2	0.0	0.0	0.0	
28	1.8	3.3	1.6	0.5	1.1	0.5	0.1	1.3	0.0	0.2	
29	0.8	1.8	2.5	0.0	0.0	0.0	0.3	1.5	0.1	0.0	
30	3.0	13.0	33.9	27.3	8.4	0.5	0.5	5.0	0.1	0.0	
31	1.3	4.0	6.7	14.2	0.0	1.6	0.2	0.6	0.0	0.0	
32	5.5	15.3	22.1	14.2	1.6	1.6	0.7	0.7	0.0	0.0	
33	2.3	1.5	6.2	0.0	0.0	0.0	0.1	0.4	1.0	0.1	
34	3.0	6.1	3.0	0.5	1.6	0.0	0.1	0.2	0.0	0.0	
35	6.8	17.1	36.7	44.1	3.7	2.2	0.6	4.0	0.3	0.0	
36	2.5	3.3	3.3	0.0	0.5	0.6	2.1	0.0	0.0	0.0	
37	4.5	10.7	5.6	4.7	2.6	0.5	3.9	6.3	0.0	0.0	
38	1.5	1.8	3.2	1.6	1.1	6.0	0.1	0.6	0.0	0.0	
39	1.8	4.3	3.3	0.0	0.5	0.0	0.0	0.7	0.1	0.0	
40	1.0	5.5	3.8	1.8	37.8	0.5	1.4	17.2	0.0	0.0	

ABERDEEN 1996: AREA UNDER DISEASE PROGRESS CURVE: RHYNCHOSPORIUM								
TREAT	LEAF 1	LEAF 2	LEAF 3	LEAF 4	LEAF 5	LEAF 6	LEAF 7	
1	38.1	309.8	375.6	324.0	464.7	1053.9	296.1	
2	89.6	288.7	418.2	196.7	437.7	412.2	375.0	
3	26.4	223.1	423.3	197.6	682.9	487.4	382.5	
4	21.4	291.6	412.0	204.2	519.2	547.8	339.1	
5	5.5	131.5	320.9	220.9	475.1	430.3	322.5	
6	16.3	178.4	342.5	192.5	383.2	522.5	349.6	
7	26.2	308.3	457.0	186.2	363.6	645.5	421.5	
8	28.2	250.3	473.5	257.3	500.3	888.6	340.9	
9	16.2	278.8	471.2	194.7	529.7	809.6	331.7	
10	6.4	256.6	402.0	313.0	401.8	913.7	365.9	
11	8.7	206.9	398.4	262.3	278.9	590.2	346.6	
12	15.1	137.3	288.1	206.2	339.5	745.5	281.4	
13	1.9	133.5	322.9	235.7	429.7	633.8	395.8	
14	1.8	128.3	282.3	193.3	463.5	930.2	335.6	
15	14.7	251.5	465.2	253.7	681.1	339.5	314.8	
16	15.9	116.9	312.3	184.1	297.9	391.2	315.4	
17	7.0	111.0	290.7	192.9	414.0	460.8	412.2	
18	13.4	208.2	338.5	206.8	347.4	552.7	369.8	
19	20.6	240.2	380.0	195.8	224.1	870.3	336.2	
20	2.7	93.6	191.6	193.5	557.9	558.1	435.5	
21	0.0	99.4	302.4	138.2	392.0	511.8	381.3	
22	0.0	92.8	343.5	152.9	305.1	566.1	407.5	
23	20.5	243.6	324.8	275.7	477.2	606.4	281.0	
24	20.6	125.8	348.8	159.5	445.0	589.2	386.8	
25	7.4	187.4	304.6	169.4	284.8	576.3	408.9	
26	6.0	105.0	294.9	180.8	503.4	339.7	383.0	
27	0.0	95.7	231.4	253.8	438.0	366.8	400.2	
28	2.0	92.8	301.9	184.6	351.0	278.6	366.2	
29	4.4	95.0	223.2	116.8	335.9	407.8	524.8	
30	67.7	296.6	321.4	119.3	210.9	328.9	436.5	
31	9.7	122.8	268.6	127.9	297.5	401.9	352.7	
32	18.3	246.1	437.2	269.6	429.9	265.5	316.6	
33	1.6	66.4	320.9	221.7	342.9	287.1	401.5	
34	7.6	137.8	282.1	168.0	194.2	332.0	423.3	
35	31.2	253.1	242.4	203.3	260.5	259.6	412.2	
36	1.0	84.2	298.5	199.8	403.5	162.0	434.0	
37	1.9	68.9	240.8	145.1	187.7	373.6	249.9	
38	5.0	73.7	228.8	134.3	254.5	355.6	324.2	
39	0.3	72.0	298.4	151.7	440.4	420.6	358.0	
40	9.5	137.2	311.0	190.5	503.4	467.9	310.1	

ABERDEEN 1996: AREA UNDER DISEASE PROGRESS CURVE: MILDEW							
TREAT	LEAF 1	LEAF 2	LEAF 3	LEAF 4	LEAF 5	LEAF 6	LEAF 7
1	166.8	777.5	1054.8	169.1	131.4	693.1	208.6
2	317.5	1102.3	1093.4	209.7	257.7	695.6	333.5
3	74.1	466.3	380.3	53.4	164.7	745.9	282.6
4	75.0	552.0	443.6	47.1	392.3	422.3	196.6
5	68.2	382.2	214.3	46.8	193.1	780.0	232.8
6	92.5	484.4	375.7	27.4	135.6	1254.9	275.5
7	102.7	474.3	832.5	119.4	245.4	1129.5	278.9
8	8.0	215.5	853.2	158.3	341.4	1285.1	220.7
9	0.9	129.4	592.2	121.1	203.2	1002.8	235.7
10	0.6	157.5	709.0	126.7	159.8	933.7	186.3
11	0.6	101.1	532.4	73.5	166.1	882.2	231.0
12	0.9	53.8	218.2	58.5	138.9	1050.0	221.3
13	4.5	65.4	149.2	48.9	168.9	776.5	336.2
14	0.6	26.6	184.6	49.6	250.8	751.7	248.7
15	209.9	787.3	823.6	60.4	79.2	332.6	245.8
16	111.0	478.9	349.3	58.8	73.9	834.3	191.9
17	19.0	148.2	200.6	30.0	229.8	646.1	127.7
18	0.0	88.5	377.6	52.3	86.1	553.9	251.5
19	1.7	217.5	778.7	104.4	104.4	944.1	276.6
20	1.2	37.3	135.0	50.0	167.5	542.9	206.1
21	2.4	38.5	182.8	23.4	98.6	859.7	170.3
22	4.1	21.2	102.6	26.2	109.2	629.3	273.7
23	195.8	671.0	587.9	70.9	101.4	603.5	232.7
24	120.8	422.3	342.6	36.4	90.2	325.6	230.3
25	3.6	107.0	390.3	49.5	109.1	757.0	224.5
26	2.7	107.1	251.6	40.1	89.5	290.3	188.5
27	0.9	21.7	90.0	13.9	72.6	455.2	311.9
28	0.3	4.3	61.2	17.6	69.8	289.4	272.3
29	0.3	23.7	88.5	25.7	173.8	492.6	219.3
30	179.8	562.6	572.1	42.8	74.0	345.3	187.0
31	188.4	632.8	492.2	33.3	20.0	210.0	141.0
32	18.3	218.7	390.5	80.1	42.6	180.7	213.8
33	6.9	38.7	88.3	18.2	57.2	457.1	163.9
34	1.0	86.8	143.1	30.7	37.2	326.0	199.9
35	160.7	645.9	398.7	46.1	94.1	226.1	256.3
36	5.7	49.1	80.0	20.7	364.1	219.8	199.0
37	1.2	31.2	119.8	22.3	13.6	433.1	220.8
38	2.4	53.1	164.5	21.9	84.2	249.7	229.9
39	0.0	27.3	123.4	20.4	44.0	245.2	226.7
40	35.9	128.5	313.4	74.4	144.5	867.8	257.7

ABERDEEN 1996: AREA UNDER DISEASE PROGRESS CURVE: BROWN RUST							
TREAT	LEAF 1	LEAF 2	LEAF 3	LEAF 4	LEAF 5	LEAF 6	LEAF 7
1	0.0	0.9	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	105.0	190.0	0.0
3	0.3	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	40.0	150.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	1.0	0.0	0.0	0.0	35.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	2.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24	0.0	0.0	0.0	0.0	0.0	235.0	0.0
25	0.0	0.0	0.0	0.0	0.0	0.0	0.0
26	0.0	0.0	0.0	0.0	20.0	120.0	0.0
27	0.0	0.0	0.0	0.0	0.0	0.0	0.0
28	0.0	0.0	0.0	0.0	0.0	0.0	0.0
29	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	0.0	0.0	0.0	0.0	0.0	0.0	0.0
31	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32	0.0	0.0	0.0	0.0	20.0	60.0	0.0
33	0.0	0.0	0.0	0.0	35.0	105.0	0.0
34	0.0	0.0	0.0	0.0	0.0	0.0	0.0
35	0.5	0.0	0.0	0.0	0.0	0.0	0.0
36	0.0	0.0	0.0	0.0	5.0	225.0	0.0
37	0.0	0.0	0.0	0.0	0.0	0.0	0.0
38	0.0	0.0	0.0	0.0	0.0	0.0	0.0
39	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40	0.0	0.0	0.0	0.0	0.0	0.0	0.0

ABERDEEN 1996: AREA UNDER DISEASE PROGRESS CURVE: NET BLOTCH							
TREAT	LEAF 1	LEAF 2	LEAF 3	LEAF 4	LEAF 5	LEAF 6	LEAF 7
1	1.0	18.0	0.0	0.0	1.9	0.0	0.0
2	1.2	4.9	5.0	0.0	1.0	0.0	0.0
3	0.6	1.8	2.0	0.0	0.0	4.3	0.0
4	0.6	10.1	1.5	0.0	2.9	2.4	0.0
5	2.6	10.5	0.0	0.0	0.0	0.0	0.0
6	0.0	14.1	0.0	1.6	0.0	0.0	0.0
7	4.1	6.4	3.5	0.0	0.0	0.0	0.0
8	0.0	3.3	0.0	0.0	4.2	0.0	0.0
9	0.0	6.6	1.0	0.0	0.0	90.0	0.0
10	0.6	4.7	5.5	1.0	0.0	0.0	0.0
11	0.6	28.7	9.7	14.0	5.3	25.0	0.0
12	0.0	5.4	8.5	0.0	1.4	0.0	0.0
13	3.0	12.3	1.0	1.1	0.0	0.0	0.0
14	0.0	8.0	1.5	1.1	0.0	0.0	0.0
15	1.2	23.1	0.0	0.0	16.0	206.9	0.0
16	0.0	4.5	0.0	0.0	1.9	0.0	0.0
17	0.0	11.1	0.0	0.0	0.0	0.0	0.0
18	0.0	16.2	0.0	0.0	1.0	3.8	0.0
19	0.0	2.1	0.0	2.1	1.0	1.4	0.0
20	0.0	13.0	6.5	1.1	1.4	50.0	0.0
21	3.7	11.2	9.2	0.0	1.0	0.0	0.0
22	0.0	14.3	4.5	0.0	1.4	4.3	0.0
23	6.8	18.6	0.0	0.0	2.1	1.4	0.0
24	2.4	5.1	5.5	0.0	135.0	85.0	0.0
25	1.2	3.9	5.7	0.0	0.0	2.9	0.0
26	0.0	8.4	1.5	0.0	160.0	11.0	0.0
27	1.5	28.7	7.5	3.7	1.0	0.0	0.0
28	0.0	4.2	6.6	5.3	87.2	130.7	0.0
29	3.5	9.0	1.5	0.0	1.6	2.4	0.0
30	1.2	7.9	0.0	0.0	0.0	0.0	0.0
31	0.0	10.9	2.5	0.0	0.0	1.4	0.0
32	0.0	5.7	0.0	0.0	150.0	235.0	0.0
33	0.0	4.5	0.0	0.0	108.5	0.0	0.0
34	0.3	15.9	20.5	0.0	0.0	2.9	0.0
35	0.0	15.2	0.0	0.0	1.0	0.5	0.0
36	0.9	12.2	0.0	0.0	0.0	1.4	0.0
37	0.0	2.4	0.0	0.0	0.5	1.0	0.0
38	1.5	5.1	4.5	1.1	2.1	4.3	0.0
39	0.6	16.5	8.5	0.0	11.0	50.0	0.0
40	0.4	13.7	3.1	0.7	2.1	55.9	0.0

MORLEY 1996: AREA UNDER DISEASE PROGRESS CURVE: RHYNCHOSPORIUM								
TREAT	LEAF 1	LEAF 2	LEAF 3	LEAF 4	LEAF 5	LEAF 6	LEAF 7	
1	0.0	0.0	0.0	0.0	0.3	0.0	0.0	
2	0.0	1.7	0.0	1.8	2.7	0.7	0.0	
3	0.0	1.6	0.6	7.8	2.0	0.7	0.0	
4	0.3	0.0	0.0	1.2	0.0	5.4	0.0	
5	0.0	1.1	0.0	3.0	0.0	5.2	1.1	
6	0.5	3.3	0.0	4.4	0.0	4.7	0.0	
7	0.0	0.0	6.4	12.9	0.3	5.1	0.0	
8	0.6	0.0	0.6	2.7	0.0	0.7	0.0	
9	0.0	0.0	1.1	0.0	0.0	2.8	0.0	
10	0.0	0.0	2.9	0.6	0.3	1.4	0.0	
11	0.0	0.6	0.5	1.1	1.8	2.0	3.0	
12	0.0	0.6	0.0	2.3	0.0	1.4	0.0	
13	0.0	0.0	0.0	4.8	0.0	4.7	0.0	
14	0.0	0.0	0.0	0.0	0.8	5.4	0.0	
15	0.3	0.8	0.0	0.9	0.6	0.7	0.2	
16	0.0	0.0	0.0	0.0	2.1	0.7	0.0	
17	0.0	0.0	0.0	4.4	5.8	0.7	0.0	
18	0.0	0.3	0.0	1.2	0.3	2.4	0.0	
19	0.0	0.7	0.0	1.2	0.0	3.7	0.0	
20	0.0	0.0	0.0	1.2	1.4	3.0	0.0	
21	0.0	0.0	0.0	0.0	1.4	3.4	0.0	
22	0.0	0.0	0.0	0.0	0.0	1.7	0.0	
23	0.6	2.3	0.0	0.0	0.3	4.9	0.0	
24	0.0	0.5	0.0	0.3	0.3	6.1	0.0	
25	0.0	0.0	0.0	0.6	3.9	3.4	0.0	
26	0.0	0.0	0.0	1.2	0.0	2.0	0.0	
27	0.0	0.0	0.6	0.0	0.0	2.0	0.7	
28	0.0	0.0	0.0	0.0	0.3	0.0	0.0	
29	0.6	0.6	0.0	2.6	1.2	4.7	0.0	
30	0.0	0.0	3.0	0.0	4.6	6.1	0.0	
31	0.0	0.0	0.0	0.0	0.0	2.0	0.0	
32	0.0	0.0	0.0	0.0	0.7	1.4	0.0	
33	0.0	0.0	0.0	0.8	0.0	64.1	0.0	
34	0.0	0.6	0.0	0.3	1.2	0.0	0.0	
35	0.0	2.9	1.1	1.2	0.0	4.1	0.0	
36	0.0	0.0	0.0	3.6	0.3	0.0	1.4	
37	0.0	0.0	0.0	0.6	1.4	4.7	0.0	
38	0.0	0.6	0.0	0.0	2.4	2.0	0.0	
39	0.0	0.0	0.0	0.0	0.0	4.7	0.0	
40	0.0	0.9	0.0	1.9	1.8	9.8	1.4	
41	0.0	0.0	0.0	7.8	0.0	0.0	0.0	
42	0.0	0.6	0.0	1.1	0.0	4.8	0.0	
43	0.0	0.0	0.0	1.8	1.2	0.7	0.0	
44	0.0	0.0	0.0	0.6	0.5	0.0	0.0	

MORLEY 1996: AREA UNDER DISEASE PROGRESS CURVE: MILDEW							
TREAT	LEAF 1	LEAF 2	LEAF 3	LEAF 4	LEAF 5	LEAF 6	LEAF 7
1	4.1	28.0	13.8	6.8	2.3	5.1	16.5
2	1.9	30.1	8.5	3.5	3.7	2.7	4.6
3	15.2	15.7	1.4	4.4	3.6	13.2	16.6
4	9.7	14.8	1.9	3.4	5.9	3.1	4.4
5	3.6	8.5	0.0	0.3	0.9	4.1	10.2
6	2.5	4.9	0.0	0.0	8.3	3.9	8.4
7	3.0	17.7	4.6	5.8	4.9	9.5	5.3
8	0.9	6.3	1.3	4.7	0.1	4.1	11.6
9	0.0	1.4	0.0	0.9	0.5	5.9	6.7
10	0.0	2.7	0.1	3.5	1.9	5.8	8.6
11	0.0	0.0	0.4	5.9	4.8	6.7	5.4
12	0.0	0.6	0.0	4.0	4.2	2.6	15.4
13	0.3	1.1	1.9	5.7	2.8	4.7	10.3
14	0.0	0.0	0.0	2.7	4.1	9.1	7.4
15	2.5	19.7	4.1	0.6	0.8	2.4	5.3
16	12.8	7.5	0.0	0.9	0.0	1.1	5.4
17	0.0	1.9	0.0	0.0	0.6	2.6	10.0
18	0.0	0.0	0.0	0.0	0.6	2.1	9.1
19	0.0	2.4	0.6	1.4	0.0	2.7	4.7
20	0.3	2.0	0.0	0.3	0.0	7.5	10.1
21	0.0	0.0	0.0	0.4	0.1	4.9	17.0
22	0.0	0.0	0.0	0.4	0.9	1.0	5.1
23	3.9	26.8	3.1	0.6	0.6	0.9	10.5
24	3.3	10.6	0.0	0.1	0.3	3.4	6.8
25	0.3	4.1	1.1	0.3	0.9	2.4	7.5
26	0.6	0.4	0.3	0.0	0.3	0.3	8.4
27	0.2	1.4	0.0	0.0	0.0	5.1	9.8
28	0.0	0.3	0.0	0.3	0.3	4.8	9.6
29	0.0	0.3	0.0	0.6	0.4	4.3	16.6
30	3.3	19.3	4.0	0.1	0.9	0.2	9.6
31	2.4	8.3	0.3	0.0	0.6	6.4	9.1
32	0.0	4.5	0.0	0.0	0.4	1.7	7.0
33	0.0	1.5	0.0	0.3	2.1	4.6	13.7
34	0.0	0.3	0.0	0.0	0.3	3.4	5.1
35	3.0	11.9	1.9	0.6	0.0	0.7	7.9
36	0.2	1.5	0.0	0.0	0.1	3.5	7.0
37	3.1	12.7	0.0	0.1	0.0	3.8	18.0
38	0.3	2.1	0.0	0.3	0.3	4.7	8.8
39	0.0	0.0	0.0	0.0	0.3	5.7	8.1
40	0.0	1.2	0.0	0.4	0.7	1.4	7.4
41	0.0	0.3	0.0	0.8	1.3	5.7	11.0
42	0.0	2.2	0.0	1.4	0.6	6.1	21.7
43	0.6	0.3	0.0	5.7	2.2	8.5	5.1
44	0.0	0.0	0.0	2.1	0.9	11.2	9.8

MORLEY 1996: AREA UNDER DISEASE PROGRESS CURVE:BROWN RUST							
TREAT	LEAF 1	LEAF 2	LEAF 3	LEAF 4	LEAF 5	LEAF 6	LEAF 7
1	1.2	3.1	1.2	0.8	0.0	0.0	0.0
2	0.7	2.3	2.4	1.6	0.5	0.0	0.0
3	1.1	4.0	0.2	0.3	0.7	0.1	0.1
4	0.4	1.8	0.2	3.5	1.4	0.0	0.1
5	0.2	1.5	0.1	0.1	0.2	0.2	0.0
6	0.3	0.6	0.0	0.1	1.6	0.1	0.0
7	1.0	2.8	1.9	7.7	2.4	0.1	0.1
8	0.4	2.9	0.9	2.8	0.8	0.1	0.0
9	0.2	0.7	0.1	0.3	0.2	0.1	0.0
10	0.2	0.8	0.1	0.4	0.3	0.1	0.0
11	0.1	0.4	0.1	2.0	1.3	0.2	0.2
12	0.4	0.5	0.0	0.9	0.5	0.1	0.0
13	1.3	0.8	0.1	0.5	1.7	0.1	0.0
14	0.1	0.3	0.0	0.1	0.3	0.1	0.0
15	0.7	1.5	0.1	0.5	0.0	0.0	0.0
16	0.5	0.7	0.3	0.1	0.0	0.3	0.1
17	0.3	0.7	0.0	0.1	0.1	0.0	0.1
18	0.2	0.5	0.1	0.0	0.0	0.1	0.1
19	0.3	0.8	0.1	0.0	0.1	0.0	0.0
20	0.1	0.5	0.0	0.0	0.1	0.0	0.0
21	0.3	0.5	0.1	0.2	0.1	1.0	0.0
22	0.2	0.2	0.0	0.0	0.0	0.0	0.0
23	1.1	1.9	0.0	0.2	0.0	0.1	0.1
24	0.6	3.4	0.1	0.0	0.1	0.0	0.4
25	0.2	0.5	0.2	0.1	0.0	0.0	0.4
26	0.3	0.4	0.0	0.0	0.0	0.7	0.1
27	0.1	0.5	0.0	0.3	0.1	0.1	0.1
28	0.2	0.8	0.0	0.0	0.0	0.0	0.1
29	0.0	0.1	0.0	0.1	0.1	0.3	0.0
30	0.9	1.8	0.2	0.2	0.0	0.0	0.0
31	1.2	2.0	0.0	0.0	0.0	0.0	0.0
32	0.2	1.3	0.0	0.0	0.0	0.0	0.0
33	0.1	0.0	0.1	0.1	0.0	0.0	0.4
34	0.2	0.3	0.0	0.1	0.0	0.0	0.0
35	0.8	2.1	0.2	0.1	0.0	0.0	0.0
36	0.6	0.5	0.0	0.0	0.0	0.0	0.0
37	0.7	6.6	0.2	0.1	0.0	0.1	0.1
38	0.2	0.3	0.3	0.4	0.3	0.0	0.1
39	0.4	0.4	0.0	0.1	0.0	0.0	0.1
40	0.0	0.1	0.1	0.1	0.4	0.1	0.1
41	0.2	0.2	0.0	0.1	0.1	0.1	0.0
42	0.1	0.6	0.0	0.7	0.6	0.0	0.0
43	0.2	0.5	0.0	0.2	0.8	0.0	0.0
44	0.1	0.2	0.0	0.1	0.1	0.0	0.1

MORLEY 1996: AREA UNDER DISEASE PROGRESS CURVE: NET BLOTCH							
TREAT	LEAF 1	LEAF 2	LEAF 3	LEAF 4	LEAF 5	LEAF 6	LEAF 7
1	0.3	6.7	9.8	35.1	14.8	90.7	46.9
2	0.6	22.7	15.7	52.6	15.1	64.7	38.9
3	0.8	12.1	25.8	90.2	20.6	52.4	40.6
4	0.0	8.3	25.2	77.2	26.1	71.7	55.3
5	1.7	11.3	14.8	51.4	21.5	54.3	37.1
6	0.0	5.4	11.4	50.2	9.2	44.3	28.7
7	1.1	10.8	25.6	53.3	20.2	37.5	46.2
8	0.0	4.2	32.8	70.5	29.4	54.7	39.6
9	0.0	7.4	16.5	39.4	30.1	70.8	52.2
10	1.7	28.3	47.1	112.2	24.3	77.8	42.7
11	0.0	7.2	25.9	101.1	29.9	46.5	49.4
12	0.1	15.6	41.0	61.3	20.4	59.6	42.7
13	0.0	8.3	17.2	59.1	33.9	51.0	43.1
14	0.0	6.2	16.8	61.8	21.1	56.9	36.1
15	0.6	9.4	20.5	78.2	13.7	48.1	35.4
16	0.3	2.1	13.2	48.5	16.1	46.0	32.2
17	0.0	5.9	27.0	60.3	20.5	58.7	48.0
18	2.4	26.5	38.0	131.2	25.2	84.5	32.9
19	1.2	6.6	19.6	67.6	19.1	51.2	44.1
20	0.0	4.9	21.3	55.2	26.7	70.3	39.9
21	0.0	4.7	12.7	86.8	11.4	48.9	38.9
22	0.0	2.7	12.8	27.5	9.1	54.8	37.1
23	1.5	9.3	48.4	49.2	24.3	51.0	40.4
24	0.2	13.3	29.0	58.8	15.4	81.9	64.4
25	0.0	3.3	19.0	43.5	33.3	73.1	48.3
26	0.0	12.2	15.0	50.6	15.0	40.3	43.8
27	0.0	9.3	7.5	29.2	16.7	58.9	34.0
28	0.0	11.4	15.8	50.7	20.4	63.6	36.1
29	0.0	3.8	3.5	76.3	34.0	70.9	37.8
30	0.0	5.2	22.8	63.4	20.4	37.5	34.7
31	0.5	16.1	22.0	50.7	26.4	51.7	34.7
32	1.1	7.1	17.8	44.3	12.5	54.1	36.1
33	0.3	9.6	28.5	64.4	26.8	70.3	56.0
34	0.2	12.2	40.4	57.8	20.7	72.3	35.4
35	1.9	14.6	38.0	39.5	8.4	64.3	38.9
36	0.0	15.0	53.9	43.6	22.6	54.3	36.8
37	1.1	7.3	30.2	24.4	24.6	57.2	39.9
38	0.0	11.6	13.3	54.3	18.7	74.0	45.5
39	0.0	5.4	7.0	55.4	17.8	55.5	41.7
40	0.0	5.2	17.3	44.2	20.8	56.5	36.4
41	0.0	5.2	31.8	120.2	34.1	84.6	45.2
42	0.2	8.9	22.4	72.5	32.2	35.5	32.2
43	0.6	8.3	20.2	63.4	35.2	47.5	43.4
44	0.0	7.5	31.1	56.3	26.0	91.8	35.0

ROSEMAUND 1996: AREA UNDER DISEASE PROGRESS CURVE: RHYNCHOSPORIUM										
TREAT	LEAF 1	LEAF 2	LEAF 3	LEAF 4	LEAF 5	LEAF 6	LEAF 7	LEAF 8	LEAF 9	LEAF 10
1	7.5	36.7	203.2	196.9	27.0	55.2	47.8	29.7	4.5	0.0
2	3.5	32.7	321.2	347.2	77.7	57.1	134.3	17.1	1.5	0.0
3	3.5	41.2	226.9	123.3	41.7	35.2	113.6	45.3	18.0	0.0
4	0.3	24.2	166.3	175.9	27.3	76.2	130.8	15.3	18.9	0.0
5	3.3	29.6	187.2	158.5	28.2	59.0	94.7	6.6	7.2	0.0
6	0.0	12.5	151.5	119.1	31.6	92.5	47.2	19.5	33.0	0.0
7	1.3	11.8	308.8	375.5	59.3	66.6	90.9	9.0	11.1	0.0
8	2.0	24.3	315.4	233.5	28.0	39.1	46.1	15.9	18.9	0.0
9	0.3	23.0	391.4	236.6	30.9	54.3	57.3	17.7	14.4	0.0
10	1.0	20.4	226.6	239.6	68.9	81.7	59.8	29.4	9.0	0.0
11	0.3	21.2	232.8	191.8	47.8	90.1	81.9	24.3	37.5	0.0
12	1.8	6.1	96.0	118.8	26.6	76.6	102.0	33.3	7.5	0.0
13	0.5	9.8	147.9	111.8	44.1	51.6	70.1	14.4	3.0	0.0
14	0.0	15.6	128.8	100.1	28.6	63.5	107.5	27.3	12.6	0.0
15	5.0	24.7	270.0	296.3	43.8	23.6	91.4	18.0	7.5	0.0
16	1.5	14.4	101.7	93.9	19.0	28.9	75.3	31.8	13.2	0.0
17	0.3	24.1	157.7	159.8	53.0	12.0	70.9	30.6	0.0	0.0
18	0.0	11.5	176.6	169.7	37.9	53.3	105.9	28.8	19.5	0.0
19	0.0	15.2	224.2	177.2	84.4	21.0	51.4	26.4	3.0	0.0
20	0.8	6.3	82.7	140.5	22.8	10.1	34.8	19.8	11.4	0.0
21	1.0	2.8	87.6	128.7	15.8	12.7	42.4	11.1	4.2	0.0
22	0.5	1.6	64.3	61.0	12.6	14.1	53.0	7.8	1.5	0.0
23	3.8	20.5	134.7	234.2	48.7	14.5	62.4	28.8	3.0	0.0
24	0.0	3.8	76.8	102.1	26.4	8.1	37.7	23.4	8.4	0.0
25	7.3	22.8	184.1	171.9	33.8	11.2	56.7	28.8	15.0	0.0
26	2.0	11.2	83.0	88.4	22.3	20.1	66.3	22.8	9.0	0.0
27	0.0	3.1	79.2	119.8	18.5	11.5	37.3	17.1	16.5	0.0
28	0.3	7.6	50.0	55.3	10.3	17.5	50.8	19.8	7.8	0.0
29	0.5	7.4	97.4	109.9	17.8	4.6	35.2	25.5	17.1	0.0
30	3.0	11.8	169.9	173.3	22.3	7.1	39.4	30.6	8.1	0.0
31	1.8	4.5	93.2	105.5	15.3	9.7	61.3	9.9	9.9	0.0
32	0.8	8.9	203.6	263.3	23.8	9.1	49.3	28.2	9.0	0.0
33	0.5	5.0	93.0	119.4	28.5	12.3	79.5	20.1	3.0	0.0
34	1.8	8.3	65.4	154.0	11.4	18.6	73.2	18.0	19.5	0.0
35	2.8	19.0	131.2	186.1	40.7	5.6	51.8	21.9	34.8	0.0
36	2.6	11.3	64.7	123.3	12.6	12.2	70.3	6.6	12.6	0.0
37	0.0	3.8	92.4	108.9	9.8	11.1	41.3	23.7	24.0	0.0
38	1.5	1.0	66.2	81.8	20.2	24.5	56.9	21.3	12.9	0.0
39	0.0	10.1	61.0	85.9	15.3	40.0	36.6	42.3	1.5	0.0
40	0.3	12.9	98.4	113.5	36.7	45.4	69.8	31.8	13.6	0.0

ROSEMAUND 1996: AREA UNDER DISEASE PROGRESS CURVE: MILDEW											
TREAT	LEAF 1	LEAF 2	LEAF 3	LEAF 4	LEAF 5	LEAF 6	LEAF 7	LEAF 8	LEAF 9	LEAF 10	
1	37.3	148.1	139.8	39.1	79.6	87.2	59.9	40.2	56.4	0.0	
2	23.5	151.3	137.8	46.5	56.0	38.7	37.8	36.9	144.9	0.0	
3	12.0	38.0	14.7	24.2	58.7	60.6	54.7	64.2	91.5	0.0	
4	7.5	24.5	3.3	16.9	72.7	62.7	66.4	37.5	69.0	0.0	
5	7.0	29.8	2.6	39.2	76.5	61.2	62.3	77.4	112.8	0.0	
6	7.0	23.0	7.8	40.1	81.4	106.3	70.8	86.4	84.9	0.0	
7	8.8	47.0	66.0	49.4	88.4	63.1	22.9	55.5	66.9	0.0	
8	2.5	18.4	31.6	46.3	124.9	104.7	56.1	54.9	94.2	0.0	
9	2.3	22.4	39.0	43.0	93.8	59.7	63.4	40.2	40.8	0.0	
10	2.8	13.1	13.8	40.8	67.0	28.1	30.8	45.0	105.0	0.0	
11	0.3	8.0	3.3	32.4	114.7	45.5	52.1	46.8	72.6	0.0	
12	5.3	6.1	3.8	21.8	50.2	45.8	44.2	55.5	42.0	0.0	
13	3.0	8.8	4.1	48.7	67.4	57.6	48.4	45.0	49.5	0.0	
14	0.5	3.0	4.7	46.6	86.3	75.1	49.7	59.1	69.9	0.0	
15	19.8	63.1	70.1	10.0	7.3	10.6	17.2	73.5	81.9	0.0	
16	14.5	44.3	2.5	17.1	14.6	14.3	31.9	19.5	126.6	0.0	
17	4.8	4.8	4.7	14.2	6.8	31.0	33.2	60.9	21.0	0.0	
18	4.3	8.8	3.2	21.5	25.8	35.6	23.9	34.8	52.5	0.0	
19	2.8	5.3	8.1	8.1	8.8	5.6	40.4	32.7	54.9	0.0	
20	1.3	3.3	2.6	7.5	5.2	16.3	61.3	37.5	114.9	0.0	
21	1.3	8.3	1.0	6.5	13.7	5.1	48.7	43.5	48.3	0.0	
22	2.5	4.3	9.1	4.9	10.0	8.6	34.3	68.1	176.4	0.0	
23	17.3	62.9	43.7	3.8	6.2	5.6	29.7	29.4	74.4	0.0	
24	8.8	26.3	2.5	3.8	3.7	13.1	22.8	33.0	60.6	0.0	
25	5.0	4.8	2.6	3.8	5.3	18.1	33.1	46.5	105.0	0.0	
26	3.3	5.3	1.1	2.9	2.2	9.1	22.6	39.0	117.6	0.0	
27	1.3	8.8	0.0	6.9	7.6	27.5	39.6	60.6	86.4	0.0	
28	2.0	1.8	1.1	7.4	13.2	12.1	41.4	62.1	114.9	0.0	
29	0.5	2.8	0.0	10.1	7.6	7.7	31.9	57.0	93.0	0.0	
30	12.0	38.8	46.1	10.7	7.1	14.5	23.1	43.2	135.0	0.0	
31	13.8	44.5	8.0	3.2	2.1	4.7	23.5	49.2	112.5	0.0	
32	8.3	31.1	18.7	4.8	7.1	11.1	32.0	23.4	114.9	0.0	
33	1.3	7.3	1.6	1.1	0.0	16.2	62.5	67.5	99.9	0.0	
34	2.0	3.3	0.5	1.1	1.5	12.1	28.7	29.4	86.4	0.0	
35	16.3	57.6	36.6	3.7	6.0	42.5	45.3	41.4	105.0	0.0	
36	1.8	3.8	1.0	2.2	2.6	18.5	37.8	46.8	84.9	0.0	
37	4.8	3.8	1.0	1.1	8.3	13.1	29.7	39.9	96.3	0.0	
38	4.3	12.5	0.0	7.4	3.1	15.1	25.4	44.4	50.1	0.0	
39	1.5	4.1	1.1	2.1	2.1	19.0	22.4	34.5	27.9	0.0	
40	1.7	4.7	3.0	8.2	14.4	6.7	15.7	33.0	51.4	0.0	

ROSEMAUND 1996: AREA UNDER DISEASE PROGRESS CURVE: NET BLOTCH											
TREAT	LEAF 1	LEAF 2	LEAF 3	LEAF 4	LEAF 5	LEAF 6	LEAF 7	LEAF 8	LEAF 9	LEAF 10	
1	2.8	21.8	5.6	1.1	10.9	12.3	8.2	5.1	19.2	0.0	
2	1.5	7.0	2.1	1.5	0.0	4.4	12.9	2.4	7.5	0.0	
3	1.5	12.3	7.8	3.8	1.5	5.8	3.9	2.4	0.0	0.0	
4	0.5	13.3	5.7	0.6	1.0	3.1	8.6	1.2	9.6	0.0	
5	0.5	9.5	5.1	2.6	3.6	8.2	7.6	11.4	12.0	0.0	
6	0.8	12.3	5.5	1.1	1.0	1.6	3.6	1.2	21.3	0.0	
7	0.3	9.5	6.4	1.1	0.5	4.7	2.8	2.7	14.7	0.0	
8	0.8	13.5	11.3	3.8	1.0	5.2	15.0	3.0	9.6	0.0	
9	0.0	12.3	2.6	3.5	2.2	8.2	7.1	1.5	34.5	0.0	
10	0.3	14.8	12.1	0.6	3.7	1.1	8.4	3.9	45.3	0.0	
11	0.8	18.5	8.0	2.2	0.5	5.3	4.3	8.4	14.4	0.0	
12	0.8	13.8	7.6	0.0	0.0	2.7	3.8	1.2	7.8	0.0	
13	0.3	11.3	11.2	1.6	0.6	9.4	7.8	3.9	1.5	0.0	
14	0.0	10.8	11.1	74.5	0.5	1.1	6.2	5.1	29.4	0.0	
15	1.5	14.1	7.1	3.1	0.0	4.8	7.8	2.4	6.0	0.0	
16	0.8	12.3	8.6	1.1	3.3	8.7	5.6	1.2	6.6	0.0	
17	1.0	10.0	4.0	3.0	0.0	6.1	6.6	2.1	63.0	0.0	
18	0.0	7.5	9.2	6.6	1.7	4.6	7.7	2.1	0.9	0.0	
19	3.3	33.4	12.7	3.9	3.8	6.2	15.1	8.1	27.9	0.0	
20	0.0	17.0	12.6	3.0	14.3	7.1	12.0	6.6	11.4	0.0	
21	1.0	10.3	7.0	1.6	1.0	4.8	9.6	3.6	10.8	0.0	
22	0.5	16.9	16.8	3.6	3.2	2.1	10.1	12.0	12.0	0.0	
23	1.3	10.0	13.7	1.6	0.0	4.6	11.7	3.0	8.4	0.0	
24	0.3	13.3	15.1	1.6	1.1	8.3	4.0	1.5	23.7	0.0	
25	0.5	20.0	12.7	7.2	4.3	8.2	4.5	1.5	15.9	0.0	
26	0.3	10.0	9.1	6.5	0.0	7.2	7.5	2.1	12.0	0.0	
27	0.3	10.1	12.3	2.2	2.1	12.1	8.4	3.3	4.2	0.0	
28	0.0	14.0	9.2	0.5	0.5	11.7	5.5	0.9	19.5	0.0	
29	0.0	16.5	6.6	3.2	3.6	5.7	4.8	2.7	24.0	0.0	
30	0.0	22.3	13.2	5.9	2.6	6.2	11.9	9.3	6.0	0.0	
31	2.3	10.8	16.8	2.7	1.1	10.9	10.5	3.9	0.0	0.0	
32	0.0	14.3	11.8	3.2	1.1	5.2	3.0	3.9	8.7	0.0	
33	2.5	12.8	4.6	1.7	1.0	4.2	2.6	5.7	21.9	0.0	
34	0.0	21.0	16.0	1.6	0.5	8.8	10.4	2.4	2.4	0.0	
35	1.8	25.0	12.1	12.0	1.7	6.3	11.0	3.3	12.0	0.0	
36	0.5	21.0	5.6	7.3	2.6	12.1	6.2	3.3	17.7	0.0	
37	0.8	19.0	13.7	3.2	2.6	3.2	3.4	1.8	13.8	0.0	
38	0.8	11.6	6.6	1.1	1.1	5.2	8.9	4.2	36.6	0.0	
39	0.5	17.8	5.1	4.7	4.3	13.7	10.3	2.7	35.1	0.0	
40	1.0	9.7	6.3	4.8	0.4	7.2	12.5	3.4	13.0	0.0	

Appendix 4. Correlation coefficients of adjusted yields with a range of factors

	Aberdeen 1994	Morley 1994	Rosemaund 1994	Aberdeen 1995	Morley 1995	Rosemaund 1995	Aberdeen 1996	Morley 1996	Rosemaund 1996
Total fungicide dose	0.07	0.38	0.71	0.78	0.89	0.05	0.78	0.45	0.72
Specific weight	0.45	0.20	0.50	0.71	0.89	0.01	0.71	0.19	0.39
Thousand grain weight	0.17	0.46	-	0.61	0.93	0.31	0.79	0.27	0.52
Total disease leaf 1*	-0.19	-0.43	-0.66	-0.73	-0.85	-0.21	-0.81	0.07	-0.70
Total disease leaf 2	-0.04	-0.18	-0.74	-0.84	-0.95	-0.28	-0.89	-0.33	-0.78
Total disease leaf 3	-0.04	-0.11	-0.74	-0.79	-0.92	-0.24	-0.72	-0.21	-0.74
Total disease leaf 4	-0.08	-0.43	-0.49	-0.63	-0.34	-0.41	-0.51	0.03	-0.50
Total disease top 5 leaves	-0.09	-0.33	-0.74	-0.86	-0.95	-0.36	-0.83	-0.21	-0.75
Total disease top 7 leaves	-0.03	-0.43	-0.66	-0.83	-0.95	-0.35	-0.69	-0.08	-0.69
Principle disease(s)	mildew Rhyncho	trace disease	mildew Rhyncho	mildew	brown rust	brown rust	mildew (Rhyncho)	trace disease	Rhyncho (mildew)
Yield response (t/ha)	0.33	0.41	1.97	1.78	3.10	0.44	1.92	0.43	1.27

Disease = Area under Disease Progress Curve (AUDPC)
* Flag leaf = leaf 1

Appendix 5. Margin over cost calculated from Surface Response Analysis (Grain at £100/t). 1994.

Aberdeen 1994							Morley 1994							Rosemaund 1994						
		GS30							GS30							GS30				
GS31/2	GS39/49	0	0.25	0.5	0.75	1	GS31/2	GS39/49	0	0.25	0.5	0.75	1	GS31/2	GS39/49	0	0.25	0.5	0.75	1
0	0	855.0	850.6	845.2	836.9	828.5	0	0	522.0	521.6	516.3	507.9	495.5	0	0	735.0	729.6	733.3	745.9	767.5
	0.25	837.6	833.3	826.9	819.5	810.1		0.25	519.6	518.2	512.9	504.5	492.1		0.25	750.6	745.3	748.9	761.5	783.1
	0.5	826.2	820.9	815.5	807.1	798.8		0.5	513.2	511.9	506.5	498.1	485.8		0.5	750.2	744.9	748.5	761.1	782.8
	0.75	819.9	815.5	809.1	801.7	792.4		0.75	502.9	502.5	497.1	488.7	476.4		0.75	733.9	728.5	732.1	744.8	766.4
	1	819.5	815.1	808.7	801.4	792.0		1	490.5	489.1	484.7	476.4	464.0		1	701.5	696.1	699.8	712.4	734.0
0.25	0	845.6	840.3	834.9	826.5	818.1	0.25	0	519.6	518.2	513.9	505.5	493.1	0.25	0	714.6	709.2	712.9	725.5	747.1
	0.25	827.2	822.9	816.5	809.1	799.8		0.25	516.3	515.9	510.5	502.1	489.8		0.25	730.2	724.9	729.5	742.1	762.8
	0.5	815.9	810.5	805.1	797.8	788.4		0.5	509.9	509.5	504.1	495.8	483.4		0.5	729.9	725.5	729.1	741.7	762.4
	0.75	809.5	805.1	798.8	791.4	782.0		0.75	500.5	499.1	494.8	486.4	474.0		0.75	713.5	708.1	712.7	724.4	746.0
	1	809.1	804.8	798.4	791.0	781.6		1	488.1	486.8	482.4	473.0	460.6		1	681.1	675.7	679.4	692.0	713.6
0.5	0	839.3	834.9	828.5	821.1	811.7	0.5	0	514.2	513.9	508.5	500.1	487.7	0.5	0	704.3	698.9	702.5	715.1	736.8
	0.25	821.9	816.5	811.1	802.7	794.4		0.25	510.9	510.5	505.1	496.7	484.4		0.25	719.9	714.5	718.1	730.7	752.4
	0.5	809.5	805.1	798.8	791.4	782.0		0.5	504.5	504.1	498.8	490.4	478.0		0.5	719.5	714.1	717.7	730.4	752.0
	0.75	803.1	798.8	792.4	785.0	775.6		0.75	495.1	493.8	489.4	481.0	468.6		0.75	703.1	697.8	701.4	714.0	735.6
	1	802.7	798.4	793.0	784.6	776.2		1	482.8	481.4	477.0	467.6	455.2		1	670.8	665.4	669.0	681.6	703.3
0.75	0	836.9	832.5	827.1	818.7	810.4	0.75	0	506.9	505.5	501.1	491.7	480.4	0.75	0	702.9	697.5	701.1	713.7	735.4
	0.25	819.5	815.1	808.7	801.4	792.0		0.25	503.5	502.1	497.8	489.4	477.0		0.25	718.5	713.1	716.7	729.4	751.0
	0.5	808.1	802.7	797.4	789.0	780.6		0.5	497.1	495.8	491.4	483.0	470.6		0.5	718.1	712.7	717.4	730.0	750.6
	0.75	801.7	797.4	791.0	783.6	774.3		0.75	487.7	486.4	482.0	472.6	460.3		0.75	701.7	696.4	700.0	712.6	734.2
	1	801.4	797.0	790.6	783.2	773.9		1	474.4	474.0	468.6	460.3	447.9		1	669.4	664.0	667.6	680.2	701.9
1	0	839.5	835.1	828.7	821.4	812.0	1	0	496.5	495.1	490.8	482.4	470.0	1	0	710.5	706.1	709.7	722.4	744.0
	0.25	822.1	817.7	811.4	804.0	794.6		0.25	493.1	491.7	487.4	479.0	466.6		0.25	727.1	721.7	725.4	738.0	759.6
	0.5	809.7	805.4	800.0	791.6	783.2		0.5	486.8	485.4	481.0	472.6	460.3		0.5	726.7	721.4	725.0	737.6	759.2
	0.75	804.4	800.0	793.6	786.2	776.9		0.75	477.4	476.0	471.6	463.2	450.9		0.75	710.4	705.0	708.6	721.3	742.9
	1	804.0	799.6	793.2	785.9	776.5		1	465.0	463.6	458.2	449.9	437.5		1	677.0	672.6	676.2	688.9	709.5

Appendix 5. Margin over cost calculated from Surface Response Analysis (Grain at £100/t). 1995.

Aberdeen 1995							Morley 1995							Rosemaund 1995						
		GS30							GS30							GS30				
GS31/2	GS39/49	0	0.25	0.5	0.75	1	GS31/2	GS39/49	0	0.25	0.5	0.75	1	GS31/2	GS39/49	0	0.25	0.5	0.75	1
0	0	805.0	802.6	800.2	798.9	796.5	0	0	563.0	591.6	608.3	611.9	603.5	0	0	589.0	595.6	589.2	569.9	537.5
	0.25	814.6	813.3	810.9	808.5	807.1		0.25	601.6	629.3	644.9	648.5	639.1		0.25	584.6	591.3	584.9	565.5	533.1
	0.5	825.2	822.9	821.5	819.1	816.7		0.5	627.3	653.9	669.5	671.1	661.8		0.5	580.2	586.9	580.5	561.1	528.8
	0.75	835.9	833.5	831.1	829.8	827.4		0.75	639.9	666.5	680.1	681.8	671.4		0.75	575.9	582.5	576.1	556.8	524.4
	1	845.5	844.1	841.7	840.4	838.0		1	640.5	666.1	678.8	679.4	668.0		1	571.5	578.1	571.7	552.4	520.0
0.25	0	849.6	847.3	845.9	843.5	841.1	0.25	0	621.6	650.2	666.9	670.5	662.1	0.25	0	587.6	594.3	587.9	568.5	536.1
	0.25	860.2	857.9	855.5	854.1	851.7		0.25	657.3	684.9	700.5	704.1	694.8		0.25	581.3	586.9	580.5	561.1	529.7
	0.5	869.9	868.5	866.1	863.8	862.4		0.5	679.9	707.5	722.1	724.8	714.4		0.5	573.9	580.5	574.1	554.7	522.4
	0.75	880.5	878.1	876.7	874.4	872.0		0.75	690.5	717.1	730.7	732.4	721.0		0.75	566.5	573.1	566.7	547.4	515.0
	1	891.1	888.8	886.4	885.0	882.6		1	688.1	712.7	726.4	727.0	715.6		1	560.1	566.7	560.4	541.0	508.6
0.5	0	874.3	871.9	870.5	868.1	865.8	0.5	0	657.3	685.9	702.5	706.1	697.8	0.5	0	587.3	593.9	586.5	568.1	535.8
	0.25	884.9	882.5	880.1	878.7	876.4		0.25	689.9	717.5	733.1	736.8	727.4		0.25	576.9	583.5	577.1	557.8	525.4
	0.5	894.5	893.1	890.8	888.4	887.0		0.5	710.5	737.1	751.7	754.4	744.0		0.5	567.5	574.1	567.7	548.4	516.0
	0.75	905.1	902.7	901.4	899.0	897.6		0.75	717.1	743.8	757.4	759.0	748.6		0.75	558.1	564.8	558.4	539.0	506.6
	1	915.8	913.4	912.0	909.6	907.3		1	711.8	737.4	751.0	751.6	739.3		1	548.8	555.4	549.0	529.6	497.2
0.75	0	878.9	877.5	875.1	872.8	871.4	0.75	0	669.9	698.5	715.1	718.8	710.4	0.75	0	585.9	592.5	586.1	566.7	534.4
	0.25	889.5	887.1	885.7	883.4	881.0		0.25	699.5	728.1	743.8	746.4	737.0		0.25	573.5	580.1	573.8	554.4	522.0
	0.5	900.1	897.8	895.4	894.0	891.6		0.5	717.1	744.8	759.4	761.0	751.6		0.5	561.1	567.7	561.4	542.0	509.6
	0.75	909.7	908.4	906.0	903.6	902.2		0.75	721.7	748.4	762.0	763.6	752.2		0.75	549.8	556.4	550.0	530.6	498.3
	1	920.4	918.0	916.6	914.3	911.9		1	713.4	739.0	751.6	752.2	740.9		1	537.4	544.0	537.6	518.2	485.9
1	0	863.5	862.1	859.7	857.4	856.0	1	0	659.5	688.1	703.8	708.4	700.0	1	0	585.5	591.1	584.7	565.4	534.0
	0.25	874.1	871.8	870.4	868.0	865.6		0.25	686.1	714.8	730.4	733.0	723.6		0.25	570.1	576.7	570.4	551.0	518.6
	0.5	884.7	882.4	880.0	878.6	876.2		0.5	700.7	728.4	743.0	745.6	735.2		0.5	555.7	562.4	556.0	536.6	504.2
	0.75	894.4	893.0	890.6	888.3	886.9		0.75	702.4	729.0	742.6	744.2	733.9		0.75	540.4	547.0	540.6	521.2	488.9
	1	905.0	902.6	901.2	898.9	896.5		1	692.0	716.6	730.3	730.9	719.5		1	526.0	532.6	526.2	506.9	474.5

Appendix 5. Margin over cost calculated from Surface Response Analysis (Grain at £100/t). 1996.

Aberdeen 1996							Morley 1996							Rosemaund 1996						
		GS30							GS30							GS30				
GS31/2	GS39/49	0	0.25	0.5	0.75	1	GS31/2	GS39/49	0	0.25	0.5	0.75	1	GS31/2	GS39/49	0	0.25	0.5	0.75	1
0	0	772.0	778.6	786.2	792.9	799.5	0	0	703.0	700.6	696.2	688.9	678.5	0	0	650.0	653.6	656.3	659.9	662.5
	0.25	814.6	817.2	819.9	821.5	824.1		0.25	704.6	703.3	698.9	691.5	680.1		0.25	660.6	659.2	656.9	655.5	653.1
	0.5	840.3	837.9	836.5	834.1	831.8		0.5	700.2	698.9	694.5	687.1	676.7		0.5	671.2	664.9	657.5	651.1	643.8
	0.75	847.9	841.5	835.1	828.7	822.4		0.75	690.9	688.5	684.1	676.7	666.4		0.75	681.9	670.5	658.1	646.7	634.4
	1	838.5	828.1	817.7	806.4	796.0		1	673.5	672.1	667.7	660.4	649.0		1	692.5	675.1	658.7	642.4	625.0
0.25	0	788.6	795.2	801.9	808.5	815.1	0.25	0	709.6	707.3	702.9	695.5	685.1	0.25	0	797.6	800.2	803.9	806.5	810.1
	0.25	831.3	833.9	835.5	838.1	840.8		0.25	711.3	709.9	705.5	698.1	686.8		0.25	808.3	805.9	804.5	802.1	800.7
	0.5	856.9	854.5	852.1	850.7	848.4		0.5	707.9	705.5	701.1	693.8	683.4		0.5	817.9	811.5	805.1	797.8	791.4
	0.75	864.5	858.1	851.7	845.4	839.0		0.75	697.5	695.1	690.8	683.4	673.0		0.75	828.5	817.1	804.8	793.4	782.0
	1	855.1	844.7	833.4	823.0	811.6		1	680.1	678.8	674.4	667.0	655.6		1	839.1	822.8	805.4	789.0	772.6
0.5	0	805.3	811.9	818.5	825.1	831.8	0.5	0	708.3	706.9	701.5	694.1	683.7	0.5	0	849.3	852.9	855.5	859.1	861.7
	0.25	847.9	849.5	852.1	854.8	856.4		0.25	709.9	708.5	704.1	696.7	685.4		0.25	859.9	857.5	856.1	854.8	852.4
	0.5	872.5	871.1	868.7	866.4	865.0		0.5	706.5	704.1	699.8	692.4	682.0		0.5	870.5	863.1	856.8	849.4	843.0
	0.75	881.1	874.8	867.4	861.0	854.6		0.75	696.1	694.8	689.4	682.0	671.6		0.75	881.1	868.7	857.4	845.0	833.6
	1	871.8	860.4	850.0	838.6	828.2		1	678.8	677.4	673.0	665.6	654.2		1	890.8	874.4	858.0	840.6	824.3
0.75	0	820.9	827.5	834.1	840.8	847.4	0.75	0	698.9	697.5	693.1	684.7	674.4	0.75	0	805.9	809.5	812.1	815.8	818.4
	0.25	863.5	866.1	867.7	870.4	873.0		0.25	701.5	699.1	694.8	687.4	677.0		0.25	816.5	815.1	812.8	811.4	809.0
	0.5	889.1	886.7	884.4	883.0	880.6		0.5	697.1	695.8	691.4	683.0	672.6		0.5	827.1	820.8	813.4	807.0	799.6
	0.75	896.8	890.4	884.0	877.6	871.3		0.75	686.8	685.4	681.0	672.6	662.3		0.75	837.8	826.4	814.0	802.6	790.3
	1	887.4	877.0	865.6	855.3	844.9		1	670.4	669.0	663.6	656.3	645.9		1	848.4	831.0	814.6	798.3	780.9
1	0	837.5	844.1	850.7	857.4	864.0	1	0	681.5	680.1	675.7	668.4	657.0	1	0	668.5	671.1	674.8	677.4	681.0
	0.25	880.1	881.8	884.4	887.0	888.6		0.25	684.1	682.8	678.4	670.0	659.6		0.25	679.1	676.7	675.4	673.0	671.6
	0.5	904.8	903.4	901.0	898.6	897.3		0.5	679.7	678.4	674.0	666.6	655.2		0.5	688.7	682.4	676.0	668.6	662.3
	0.75	913.4	907.0	900.6	894.2	887.9		0.75	669.4	668.0	663.6	656.3	644.9		0.75	699.4	688.0	675.6	664.3	652.9
	1	904.0	892.6	882.3	870.9	860.5		1	653.0	651.6	647.2	638.9	628.5		1	710.0	693.6	676.2	659.9	643.5

Appendix 5. Margin over cost calculated from Surface Response Analysis (Grain at £80/t). 1994.

Aberdeen 1994							Morley 1994							Rosemaund 1994						
		GS30							GS30							GS30				
GS31/2	GS39/49	0	0.25	0.5	0.75	1	GS31/2	GS39/49	0	0.25	0.5	0.75	1	GS31/2	GS39/49	0	0.25	0.5	0.75	1
0	0	684.0	678.8	672.8	664.5	656.1	0	0	417.6	415.6	409.7	401.3	389.7	0	0	588.0	582.0	583.3	591.7	607.3
	0.25	668.4	663.3	656.5	648.9	639.7		0.25	414.0	411.2	405.3	396.9	385.3		0.25	598.8	592.9	594.1	602.5	618.1
	0.5	657.6	651.7	645.7	637.3	629.0		0.5	407.2	404.5	398.5	390.1	378.6		0.5	596.8	590.9	592.1	600.5	616.2
	0.75	650.9	645.7	638.9	631.3	622.2		0.75	397.3	395.3	389.3	380.9	369.4		0.75	582.1	576.1	577.3	585.8	601.4
	1	648.9	643.7	636.9	629.4	620.2		1	385.7	382.9	377.7	369.4	357.8		1	554.5	548.5	549.8	558.2	573.8
0.25	0	674.8	668.9	662.9	654.5	646.1	0.25	0	414.0	411.2	406.1	397.7	386.1	0.25	0	570.0	564.0	565.3	573.7	589.3
	0.25	658.4	653.3	646.5	638.9	629.8		0.25	409.7	407.7	401.7	393.3	381.8		0.25	580.8	574.9	576.9	585.3	600.2
	0.5	647.7	641.7	635.7	628.2	619.0		0.5	402.9	400.9	394.9	386.6	375.0		0.5	578.9	573.7	574.9	583.3	598.2
	0.75	640.9	635.7	629.0	621.4	612.2		0.75	393.7	390.9	385.8	377.4	365.8		0.75	564.1	558.1	560.1	567.8	583.4
	1	638.9	633.8	627.0	619.4	610.2		1	382.1	379.4	374.2	365.0	353.4		1	536.5	530.5	531.8	540.2	555.8
0.5	0	668.1	662.9	656.1	648.5	639.3	0.5	0	408.0	406.1	400.1	391.7	380.1	0.5	0	560.1	554.1	555.3	563.7	579.4
	0.25	652.5	646.5	640.5	632.1	623.8		0.25	403.7	401.7	395.7	387.3	375.8		0.25	570.9	564.9	566.1	574.5	590.2
	0.5	640.9	635.7	629.0	621.4	612.2		0.5	396.9	394.9	389.0	380.6	369.0		0.5	568.9	562.9	564.1	572.6	588.2
	0.75	634.1	629.0	622.2	614.6	605.4		0.75	387.7	385.0	379.8	371.4	359.8		0.75	554.1	548.2	549.4	557.8	573.4
	1	632.1	627.0	621.0	612.6	604.2		1	376.2	373.4	368.2	359.0	347.4		1	526.6	520.6	521.8	530.2	545.9
0.75	0	664.5	659.3	653.3	644.9	636.6	0.75	0	400.5	397.7	392.5	383.3	372.6	0.75	0	557.3	551.3	552.5	560.9	576.6
	0.25	648.9	643.7	636.9	629.4	620.2		0.25	396.1	393.3	388.2	379.8	368.2		0.25	568.1	562.1	563.3	571.8	587.4
	0.5	638.1	632.1	626.2	617.8	609.4		0.5	389.3	386.6	381.4	373.0	361.4		0.5	566.1	560.1	562.2	570.6	585.4
	0.75	631.3	626.2	619.4	611.8	602.7		0.75	380.1	377.4	372.2	363.0	351.5		0.75	551.3	545.4	546.6	555.0	570.6
	1	629.4	624.2	617.4	609.8	600.7		1	367.8	365.8	359.8	351.5	339.9		1	523.8	517.8	519.0	527.4	543.1
1	0	664.9	659.7	652.9	645.4	636.2	1	0	390.5	387.7	382.6	374.2	362.6	1	0	561.7	556.5	557.7	566.2	581.8
	0.25	649.3	644.1	637.4	629.8	620.6		0.25	386.1	383.3	378.2	369.8	358.2		0.25	573.3	567.3	568.6	577.0	592.6
	0.5	637.7	632.6	626.6	618.2	609.8		0.5	379.4	376.6	371.4	363.0	351.5		0.5	571.3	565.4	566.6	575.0	590.6
	0.75	631.8	626.6	619.8	612.2	603.1		0.75	370.2	367.4	362.2	353.8	342.3		0.75	556.6	550.6	551.8	560.3	575.9
	1	629.8	624.6	617.8	610.3	601.1		1	358.6	355.8	349.8	341.5	329.9		1	528.2	523.0	524.2	532.7	547.5

Appendix 5. Margin over cost calculated from Surface Response Analysis (Grain at £80/t). 1995.

Aberdeen 1995							Morley 1995							Rosemaund 1995						
		GS30							GS30							GS30				
GS31/2	GS39/49	0	0.25	0.5	0.75	1	GS31/2	GS39/49	0	0.25	0.5	0.75	1	GS31/2	GS39/49	0	0.25	0.5	0.75	1
0	0	644.0	640.4	636.8	634.1	630.5	0	0	450.4	471.6	483.3	484.5	476.1	0	0	471.2	474.8	468.0	450.9	423.3
	0.25	650.0	647.3	643.7	640.1	637.3		0.25	479.6	500.1	510.9	512.1	502.9		0.25	466.0	469.7	462.9	445.7	418.1
	0.5	656.8	653.3	650.5	646.9	643.3		0.5	498.5	518.1	528.9	528.5	519.4		0.5	460.8	464.5	457.7	440.5	413.0
	0.75	663.7	660.1	656.5	653.8	650.2		0.75	506.9	526.5	535.7	535.4	525.4		0.75	455.7	459.3	452.5	435.4	407.8
	1	669.7	666.9	663.3	660.6	657.0		1	505.7	524.5	533.0	531.8	521.0		1	450.5	454.1	447.3	430.2	402.6
0.25	0	678.0	674.5	671.7	668.1	664.5	0.25	0	495.6	516.8	528.5	529.7	521.3	0.25	0	468.4	472.1	465.3	448.1	420.5
	0.25	684.8	681.3	677.7	674.9	671.3		0.25	522.5	542.9	553.7	554.9	545.8		0.25	461.7	464.5	457.7	440.5	413.7
	0.5	690.9	688.1	684.5	681.0	678.2		0.5	538.9	559.3	569.3	569.8	559.8		0.5	454.1	457.7	450.9	433.7	406.2
	0.75	697.7	694.1	691.3	687.8	684.2		0.75	545.7	565.3	574.5	574.2	563.4		0.75	446.5	450.1	443.3	426.2	398.6
	1	704.5	701.0	697.4	694.6	691.0		1	542.1	560.1	569.4	568.2	557.4		1	439.7	443.3	436.6	419.4	391.8
0.5	0	696.1	692.5	689.7	686.1	682.6	0.5	0	522.5	543.7	555.3	556.5	548.2	0.5	0	466.5	470.1	462.5	446.1	418.6
	0.25	702.9	699.3	695.7	692.9	689.4		0.25	546.9	567.3	578.1	579.4	570.2		0.25	456.5	460.1	453.3	436.2	408.6
	0.5	708.9	706.1	702.6	699.0	696.2		0.5	561.7	581.3	591.3	591.8	581.8		0.5	447.3	450.9	444.1	427.0	399.4
	0.75	715.7	712.1	709.4	705.8	703.0		0.75	565.3	585.0	594.2	593.8	583.8		0.75	438.1	441.8	435.0	417.8	390.2
	1	722.6	719.0	716.2	712.6	709.1		1	559.4	578.2	587.4	586.2	574.7		1	429.0	432.6	425.8	408.6	381.0
0.75	0	698.1	695.3	691.7	688.2	685.4	0.75	0	530.9	552.1	563.7	565.0	556.6	0.75	0	463.7	467.3	460.5	443.3	415.8
	0.25	704.9	701.3	698.5	695.0	691.4		0.25	552.9	574.1	585.0	585.4	576.2		0.25	452.1	455.7	449.0	431.8	404.2
	0.5	711.7	708.2	704.6	701.8	698.2		0.5	565.3	585.8	595.8	595.4	586.2		0.5	440.5	444.1	437.4	420.2	392.6
	0.75	717.7	715.0	711.4	707.8	705.0		0.75	567.3	587.0	596.2	595.8	585.0		0.75	429.8	433.4	426.6	409.4	381.9
	1	724.6	721.0	718.2	714.7	711.1		1	559.0	577.8	586.2	585.0	574.3		1	418.2	421.8	415.0	397.8	370.3
1	0	684.1	681.3	677.7	674.2	671.4	1	0	520.9	542.1	553.0	555.0	546.6	1	0	461.7	464.5	457.7	440.6	413.8
	0.25	690.9	687.4	684.6	681.0	677.4		0.25	540.5	561.8	572.6	573.0	563.8		0.25	447.7	451.3	444.6	427.4	399.8
	0.5	697.7	694.2	690.6	687.8	684.2		0.5	550.5	571.0	581.0	581.4	571.4		0.5	434.5	438.2	431.4	414.2	386.6
	0.75	703.8	701.0	697.4	693.9	691.1		0.75	550.2	569.8	579.0	578.6	568.7		0.75	420.6	424.2	417.4	400.2	372.7
	1	710.6	707.0	704.2	700.7	697.1		1	540.2	558.2	567.5	566.3	555.5		1	407.4	411.0	404.2	387.1	359.5

Appendix 5. Margin over cost calculated from Surface Response Analysis (Grain at £80/t). 1996.

Aberdeen 1996							Morley 1996							Rosemaund 1996						
		GS30							GS30							GS30				
GS31/2	GS39/49	0	0.25	0.5	0.75	1	GS31/2	GS39/49	0	0.25	0.5	0.75	1	GS31/2	GS39/49	0	0.25	0.5	0.75	1
0	0	617.6	621.2	625.6	629.3	632.9	0	0	562.4	558.8	553.6	546.1	536.1	0	0	520.0	521.2	521.7	522.9	523.3
	0.25	650.0	650.4	650.9	650.5	650.9		0.25	562.0	559.3	554.1	546.5	535.7		0.25	526.8	524.0	520.5	517.7	514.1
	0.5	668.9	665.3	662.5	658.9	655.4		0.5	556.8	554.1	548.9	541.3	531.3		0.5	533.6	526.9	519.3	512.5	505.0
	0.75	673.3	666.5	659.7	652.9	646.2		0.75	547.7	544.1	538.9	531.3	521.4		0.75	540.5	529.7	518.1	507.3	495.8
	1	664.1	654.1	644.1	633.4	623.4		1	532.1	529.3	524.1	516.6	505.8		1	547.3	531.7	516.9	502.2	486.6
0.25	0	629.2	632.8	636.5	640.1	643.7	0.25	0	566.0	562.5	557.3	549.7	539.7	0.25	0	636.4	636.8	638.1	638.5	639.7
	0.25	661.7	662.1	661.7	662.1	662.6		0.25	565.7	562.9	557.7	550.1	539.4		0.25	643.3	639.7	636.9	633.3	630.5
	0.5	680.5	676.9	673.3	670.5	667.0		0.5	561.3	557.7	552.5	545.0	535.0		0.5	649.3	642.5	635.7	628.2	621.4
	0.75	684.9	678.1	671.3	664.6	657.8		0.75	551.3	547.7	542.6	535.0	525.0		0.75	656.1	645.3	633.8	623.0	612.2
	1	675.7	665.7	655.0	645.0	634.2		1	535.7	533.0	527.8	520.2	509.4		1	662.9	648.2	632.6	617.8	603.0
0.5	0	640.9	644.5	648.1	651.7	655.4	0.5	0	563.3	560.5	554.5	546.9	536.9	0.5	0	676.1	677.3	677.7	678.9	679.3
	0.25	673.3	672.9	673.3	673.8	673.4		0.25	562.9	560.1	554.9	547.3	536.6		0.25	682.9	679.3	676.5	673.8	670.2
	0.5	691.3	688.5	684.9	681.4	678.6		0.5	558.5	554.9	549.8	542.2	532.2		0.5	689.7	682.1	675.4	667.8	661.0
	0.75	696.5	689.8	682.2	675.4	668.6		0.75	548.5	545.8	539.8	532.2	522.2		0.75	696.5	684.9	674.2	662.6	651.8
	1	687.4	676.6	666.6	655.8	645.8		1	533.0	530.2	525.0	517.4	506.6		1	702.6	687.8	673.0	657.4	642.7
0.75	0	651.7	655.3	658.9	662.6	666.2	0.75	0	554.1	551.3	546.1	537.7	527.8	0.75	0	639.7	640.9	641.3	642.6	643.0
	0.25	684.1	684.5	684.1	684.6	685.0		0.25	554.5	550.9	545.8	538.2	528.2		0.25	646.5	643.7	640.2	637.4	633.8
	0.5	702.9	699.3	695.8	693.0	689.4		0.5	549.3	546.6	541.4	533.0	523.0		0.5	653.3	646.6	639.0	632.2	624.6
	0.75	707.4	700.6	693.8	687.0	680.3		0.75	539.4	536.6	531.4	523.0	513.1		0.75	660.2	649.4	637.8	627.0	615.5
	1	698.2	688.2	677.4	667.5	657.5		1	524.6	521.8	515.8	508.3	498.3		1	667.0	651.4	636.6	621.9	606.3
1	0	663.3	666.9	670.5	674.2	677.8	1	0	538.5	535.7	530.5	523.0	512.2	1	0	528.1	528.5	529.8	530.2	531.4
	0.25	695.7	695.4	695.8	696.2	695.8		0.25	538.9	536.2	531.0	522.6	512.6		0.25	534.9	531.3	528.6	525.0	522.2
	0.5	713.8	711.0	707.4	703.8	701.1		0.5	533.7	531.0	525.8	518.2	507.4		0.5	540.9	534.2	527.4	519.8	513.1
	0.75	719.0	712.2	705.4	698.6	691.9		0.75	523.8	521.0	515.8	508.3	497.5		0.75	547.8	537.0	525.4	514.7	503.9
	1	709.8	699.0	689.1	678.3	668.3		1	509.0	506.2	501.0	492.7	482.7		1	554.6	539.8	524.2	509.5	494.7

APPENDIX 6

INTEGRATED DISEASE RISK STRATEGY FOR WINTER BARLEY

Determine IDR scores and apply IDR treatment only at time of application - i.e. GS 30, 31/32, 39/45.

For **each** disease below identify the appropriate score for each of the following factors.

A = Inoculum
B = Weather factors
C = Variety resistance
D = Crop Sensitivity
Calculate the risk score using the formula given and read from the chart for each disease the dose of fungicide required.

Having considered all four diseases, apply the highest dose achieved.

VARIETY RESISTANCE (C)

For all diseases the scores for variety resistance are:

Score	Disease resistance rating
0	9
1	8
2	7
3	6
4	5
5	4
6	3 or 2 or 1

Disease resistance ratings

Variety	Mildew	Brown Rust	Rhynchosporium	Net Blotch
Pastoral	3	6	7	8

MILDEW

IDR score = (2A + B + C) * D

A - Inoculum

Assess infection on 50 plants but particularly on the critical leaf layer of main stems.

Critical leaf layer:
- GS 30 - 3rd top fully expanded leaf
- GS 31/37 - 3rd top fully expanded leaf
- GS 39/49 - 4th top fully expanded leaf
- GS 51/69 - 2nd top fully expanded leaf

Score	Infection
0	No mildew on critical leaf layer and no obvious mildew on any leaf layer
1	< 50% leaves on critical leaf layer with at least one pustule or no infection on critical leaf layer but some mildew detected on plants
2	50-99% leaves on critical leaf layer with at least one pustule
3	100% leaves on critical leaf layer with mildew and mildew detected on leaves above

B - Weather

Score	Weather conditions in last fortnight
1	UNFAVOURABLE - Cool (<8^{o}C average*) or 'wet' (5 or more days in last fortnight with 1.0mm or more rain)
2	AVERAGE ie not falling into Favourable or Unfavourable categories
3	FAVOURABLE - Prolonged warm (>14^{o}C average*) and 'dry' (1 or less days in last fortnight with 1.0mm or more rain)

* average temperature is the average over the previous fortnight of the mean of the maximum and minimum for each day

C - Variety resistance (see above)

D - Crop Sensitivity

Score	Crop Growth Stage
0.75	30
3	31 to 37
2.5	39 to 49
0.75	51 onwards

Risk Score

0-9	No Fungicide
9.1-19	¼ Dose
19.1-29	½ Dose
29.1-39	¾ Dose
39.1-	1 Dose

BROWN RUST

IDR score = (A + 1.5B + C) * D

A - Inoculum

Assess infection on 50 plants but particularly on the critical leaf layer of main stems after GS37.

Critical leaf layer: GS 30 - % of tillers showing brown rust
GS 31/37 - % of tillers showing brown rust
GS 39/49 - 4th top fully expanded leaf if no prior application of fungicide
2nd top fully expanded leaf if previously sprayed with fungicide
GS 51/69 - 2nd top fully expanded leaf

Score	Infection
0	No brown rust on any tiller or critical leaf layer and no obvious brown rust on plants whatsoever
1	<30% of tillers (up to GS 37) or <30% of leaves in critical leaf layer (after GS 37) infected with brown rust
2	30-60% of tillers (up to GS 37) or leaves in the critical leaf layer (after GS 37) infected with brown rust
3	60-100% of tillers (up to GS 37) or leaves in critical leaf layer (after GS 37) infected with brown rust

B - Weather

Score	Weather conditions in last fortnight
0	Below 5^{o} C
1	UNFAVOURABLE - Cool (5-13^{o}C average*) or 'dry' (1 or less days in last fortnight with 1.0mm or more rain)
2	AVERAGE ie not falling into Favourable or Unfavourable categories
3	FAVOURABLE - Prolonged warm (>17^{o}C average*) and 2 or more days in last fortnight with 1.0mm or more rain)

* average temperature is the average over the previous fortnight of the mean of the maximum and minimum for each day

C - Variety resistance (see above)

D - Crop Sensitivity

Score	Crop Growth Stage
0.75	30
1.5	31 to 37
3.0	39 to 49
2.0	51 onwards

Risk Score

0-9	No Fungicide
9.1-19	¼ Dose
19.1-29	½ Dose
29.1-39	¾ Dose
39.1-	1 Dose

RHYNCHOSPORIUM

IDR score = (A + 2B + C) * D

A - Inoculum

Assess infection on 50 plants but particularly on the critical leaf layer of main stems.

Critical leaf layer:
- GS 30 - 3rd top fully expanded leaf
- GS 31/37 - 3rd top fully expanded leaf
- GS 39/49 - 4th top fully expanded leaf
- GS 51/69 - 2nd top fully expanded leaf

Score	Infection
0	No Rhyncho on critical leaf layer and no obvious Rhynchosporium on plants whatsoever
1	< 10% leaves on critical leaf layer with at least one lesion or no infection on critical leaf layer but some Rhynchosporium detected on plants
2	10-25% leaves on critical leaf layer with at least one lesion
3	>25% leaves on critical leaf layer with Rhynchosporium and also detected on leaves above

B - Weather

Score	Weather conditions in last fortnight
1	UNFAVOURABLE - 1 day or less in last fortnight with 1.0mm or more rain
2	AVERAGE ie not falling into Favourable or Unfavourable categories
3	FAVOURABLE - 5 or more days in last fortnight with 1.0mm or more rain

C - Variety resistance (see above)

D - Crop Sensitivity

Score	Crop Growth Stage
0.75	30
2.0	31 to 37
3.0	39 to 49
1.0	51 onwards

Risk Score

0-8	No Fungicide
8.1-16	¼ Dose
16.1-24	½ Dose
24.1-34	¾ Dose
34.1-	1 Dose

NET BLOTCH

IDR score = (A + 2B + C) * D

A - Inoculum

Assess infection on 50 plants but particularly on the critical leaf layer of main stems.

Critical leaf layer:
- GS 30 - 3rd top fully expanded leaf
- GS 31/37 - 3rd top fully expanded leaf
- GS 39/49 - 4th top fully expanded leaf
- GS 51/69 - 2nd top fully expanded leaf

Score	Infection
0	No net blotch on on critical leaf layer and no obvious or net blotch on plants whatsoever
1	< 10% leaves on critical leaf layer with at least one lesion or no infection on critical leaf layer but some net blotch detected on plants
2	10-25% leaves on critical leaf layer with at least one lesion
3	>25% leaves on critical leaf layer with net blotch and also detected on leaves above

B - Weather

Score	Weather conditions in last fortnight
1	UNFAVOURABLE - 1 day or less in last fortnight with 1.0mm or more rain
2	AVERAGE ie not falling into Favourable or Unfavourable categories
3	FAVOURABLE - 5 or more days in last fortnight with 1.0mm or more rain

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