# FINAL PROJECT REPORT

To:
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Protected Lettuce: Efficacy evaluation of azoxystrobin (Amistar) for the control of *Rhizoctonia solani*

May 2002

Commercial – In Confidence

# FINAL REPORT

**Project Title:** Protected Lettuce: Efficacy evaluation of azoxystrobin (Amistar) for the control of *Rhizoctonia solani*

**Project Number:** PC 184


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Mrs C Brewster (1 copy)
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The results and conclusions in this report are based on one replicated field trial. The conditions under which the experiment was carried out and the results have been reported with detail and accuracy. However, because of the biological nature of the work it must be borne in mind that different circumstances and conditions could produce different results. Therefore, care must be taken with interpretation of the results especially if they are used as the basis for commercial product recommendations.

**Authentication**

I declare that this work was done under my supervision according to the procedures described herein and that this report represents a true and accurate record of the results obtained.

Signature .......................................................................................

Ms C Brewster
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Date ............................

Report authorised by ..............................................................................

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# 1. Practical Section for Growers

## 1.1 Commercial benefits of the project

Without effective control measures for *Rhizoctonia solani*, cause of bottom-rot in protected lettuce, many crops would be unmarketable. With the imminent phase-out of methyl bromide, the loss of quintozene and the restrictive application regime required for tolclofos-methyl there is a genuine risk of this scenario occurring. There is therefore a financial imperative to find an alternative solution for the control of this important soil-borne pathogen. In the short-term, an alternative fungicide is required to maintain the current standard of disease control. Hopefully, in the longer-term, research and development programmes will lead to more bio-sustainable solutions in the lettuce crop and this will be a distinct advantage with respect to minimising pesticide residues in this crop.

Azoxystrobin (Amistar) is reported to have activity against *R. solani* in other crops e.g. Celery (HDC Project Report : PC/FV 173) and it is anticipated that similar activity could be expected in protected lettuce. The aim of this project therefore was to determine the effectiveness of this new strobilurin fungicide using a series of application regimes targeted at the early production stage of the crop. A separate HDC-funded project within the SOLA programme has been undertaken simultaneously to determine the residue risk from early applications[1].

The commercial benefit, if approval could be granted (subject to the outcome of the separate SOLA study), would be considerable, as it would allow growers to continue current production techniques and also 'buy' time to develop alternative bio-sustainable strategies for the protected lettuce crop.

[1] Previous residue studies, conducted as a component of the HDC-funded SOLA programme, using a 4-spray regime during crop development highlighted a residue risk during winter production of glasshouse lettuce. Further work was therefore commissioned and undertaken to determine the residue levels of azoxystrobin following a single application of Amistar applied early in the crop production cycle.

## 1.2 Background and objectives

Several crops of protected lettuce are grown intensively in the same glasshouse each year. Quality of the harvested produce is of paramount importance for continuity of supply to the major multiples. To achieve this, and in the absence of effective alternative techniques, growers rely heavily on the use of soil sterilants (usually methyl bromide (MeBr)) and soil-applied fungicides. The preferred sterilant, MeBr, is scheduled to be phased-out by 2005 and the primary fungicides (quintozene and tolclofos-methyl) approved for *Rhizoctonia* control on protected lettuce have either been revoked or had their use on the crop severely restricted. Previously, growers routinely used tolclofos-methyl (Basilex) though in the last 3-4 years numerous reports of disease (*Rhizoctonia*) control failure have been received. The precise cause of the control failure has not yet been elucidated though fungicide resistance and enhanced degradation (or a combination of the two) are the most likely explanations. As a result, however, many growers have reverted to using quintozene and the presence of new improved formulations (Terraclor 20D/Terraclor Flo) has aided this transition. Unfortunately, however, quintozene has been unsuccessful in its progress through the EU Pesticide Review Programme (EEC/91/414) and will be revoked by 27 June 2002. In reality use must cease well before this date to ensure residue levels are at or below the Limit of Determination (LoD) by this cut-off date. The industry therefore, in the short-term, has little option but to use tolclofos-methyl (Basilex) for *Rhizoctonia* control yet would appear to be thwarted in this regard also. This fungicide is an acetyl-cholinesterase (OP) product and this group of products has undergone a simultaneous UK review alongside EEC/91/414. The outcome of this national review is that use of products containing tolclofos-methyl (eg Basilex) has been restricted under protection to prevent operator exposure. Whilst the precise detail remains to be clarified, it would appear that Basilex can no longer be applied by hand-held or tractor mounted equipment and must instead be applied remotely (ie personnel not present in the structure during application). Therefore if lettuce growers are to continue to use this product they will be required to install remote gantry systems specifically for this use. It is considered that this will be prohibitive in financial terms for most growers and the temptation will be to apply it via the irrigation system. Growers must be aware that the fungicide is likely to settle out in the irrigation lines only to be flushed out as the crop is irrigated following planting out. Unacceptable (above MRL) residues of tolclofos-methyl are considered likely as a result of this approach and therefore the technique is to be avoided.

It is therefore imperative that alternative fungicides are identified and approved for the control of this and other pathogens e.g. *Sclerotinia* in protected lettuce to maintain effective disease control and to avoid unacceptable consumer risk from residues in the harvested produce. The objective of the work therefore was to evaluate the performance of the strobilurin fungicide, azoxystrobin (Amistar), applied at different early timings (pre-planting to the soil, 7 days post-planting) for the control of the soil-borne pathogen *R. solani* in winter lettuce.

### 1.3 Summary of Results and Conclusions

Amistar (azoxystrobin) was applied (1litre/ha) at four different treatment regimes to protected overwintered lettuce for the control of *R. solani,* the cause of bottom-rot in lettuce. The performance of Amistar was compared to Basilex (tolclofos-methyl) and Terraclor (quintozene); two standard fungicide treatments for the control of *R. solani* in lettuce. Trial plots were amended with prepared inoculum of a virulent isolate of *R. solani*, which was previously isolated from bottom-rot infected lettuce, before application of treatments and planting of the lettuce. Untreated uninoculated and inoculated control treatments were included in the trial.

The trial initially progressed well and hyphal threads of *Rhizoctonia* successfully colonised the soil around the lettuce plants. However, as the lettuce plants established and subsequently matured it became increasingly evident that bottom-rot infection was not establishing in the inoculated untreated control plots. Further detailed examination in the laboratory subsequently confirmed that, despite thorough inoculation with a virulent isolate of *Rhizoctonia,* infection was not establishing successfully in the trial plants. A satisfactory explanation for the lack of infection could not be proposed. The trial period was extended further to increase the opportunity for infection to occur, though at harvest the lettuce were found to be free from infection by this normally aggressive pathogen.

Fortunately, several of the trial plants did become infected with both *Botrytis cinerea* (grey mould) and *Sclerotinia sclerotiorum* (white rot) and the extended trial period allowed time for these pathogens to cause significant damage. Their occurrence provided an opportunity to evaluate the applied fungicide treatments against these two diseases. The results showed that none of the four Amistar treatment regimes provided effective control of *Botrytis* and infection occurred in all the treatment regimes. The results for *Sclerotinia* however indicated that Amistar applied at 1litre/ha as a pre-plant soil application provided protection against *Sclerotinia,* though it is not possible to discount the possibility that individual plots remained free of this natural infection. Control appeared to be comparable to Basilex (20kg/ha) and this supports earlier HDC-funded work (PC 131) on Protected Celery conducted at Stockbridge House. As indicated above though, it should be noted that the patchy distribution of this natural *Sclerotinia* infection means that the results need to be treated with caution and interpreted accordingly. It is recommended that further work would be required to be certain that the most effective treatment regimes reported here would provide a robust control of the disease under commercial conditions.

The yield data (untrimmed and trimmed lettuce (kg)) was affected by the development of both *Botrytis* and *Sclerotinia*, which caused severe rotting of many heads and therefore severely impacted on the commercial yield. The profound effect of this dual infection on head weight meant it was not possible to this data to determine the effect of the various treatments on overall crop safety. It was therefore decided to also weigh a selected sub-sample of lettuce unaffected by either pathogen in each plot. The results for this additional yield assessment demonstrated that there were no significant differences in overall crop performance between treatments. This indicates that none of the imposed treatments were phytotoxic and likely to cause crop safety concerns. Moreover, there were no visible phytotoxic effects observed in any of the trial plots during the course of the experiment.

## 1.4 Action Points for Growers

- Growers need to be aware and familiarise themselves with the EU Pesticide review (EEC/91/414) and the UK acetyl-cholinesterase (OP) review and the impact they are likely to have on their business. The 'gap analysis' recently commissioned by HDC will be of considerable benefit in this regard.
- Use of quintozene (Terraclor) must cease in advance of 27 June 2002 to ensure crops harvested after this date are free from residues of quintozene. For specific advice relating to the latest timing of application consult the manufacturer/distributor (Certis (Hortichem) UK Ltd).
- To ensure operator safety is not compromised tolclofos-methyl (Basilex) should not be applied by knapsack or tractor mounted equipment. It must instead be applied remotely i.e. no personnel in the glasshouse.
- Remote gantry systems, where available, would be an effective means of application of tolclofos-methyl. Where such equipment is not available growers will need to look carefully at the economics prior to any future installation.
- Basilex must NOT be applied via the irrigation lines, even though this could be construed as a means of remote application. It is considered likely that the fungicide would settle out in the irrigation lines only to be flushed out during routine watering operations later in the crops life. This is likely to result in unacceptable residues (above MRL) in the harvested produce.
- In the trial reported here the introduced pathogen failed to infect the lettuce crop and efficacy data to demonstrate the relative performance of Amistar was not obtained.
- *Botrytis*, however, did establish at high levels in the trial crop and Amistar proved ineffective in controlling the disease given the application regimes adopted.
- *Sclerotinia sclerotiorum* also established in the trial and preliminary data was gathered to support the view that an early soil application of Amistar may be effective against this important pathogen of winter lettuce. Further work is required in this respect.
- Whilst Amistar is already approved for use on outdoor lettuce (including butterhead types) primarily for the control of *Sclerotinia* (note - it is also likely

to have some benefit against other target pathogens due to its broad spectrum nature) it is not yet approved for use on protected lettuce. However, a SOLA application has been submitted based on concurrent studies within the SOLA programme. As soon as the data has been evaluated and a SOLA granted (assuming a satisfactory evaluation by PSD) growers will be notified via normal HDC channels.

- It is recommended that further work be undertaken to determine the relative efficacy of azoxystrobin against *R. solani* in protected winter lettuce. It may be necessary to undertake some work on commercial nurseries where there is a history of bottom-rot caused by this pathogen in future.

**1.5 Anticipated Practical and Financial Benefits**

It was hoped that data on the relative efficacy of various treatment regimes using azoxystrobin (Amistar) against *R. solani*, cause of bottom-rot in lettuce, would have been generated during the course of this study. Unfortunately, however, the failure of the pathogen to cause characteristic disease symptoms in the experimental crop thwarted the primary objective of the project on this occasion.

As *Botrytis* and *Sclerotinia* both occurred in the trial area, the opportunity was taken to gather some relevant information on these two pathogens instead. The various application regimes were ineffective in controlling *Botrytis* though *Sclerotinia* did appear to be suppressed following an early soil treatment with Amistar. However, it is important that further work is undertaken to validate this observation.

Ultimately, any practical and financial benefits from this study will only be attained if the concurrent SOLA project finds low residue levels and the Specific Off-Label Approval application is granted for an early treatment regime on protected lettuce.

In the meantime, it is imperative that further work is undertaken to determine the relative efficacy of this fungicide against *R.solani*, compared to that achieved previously with soil applications of quintozene or tolclofos-methyl.

# 2. Science Section

## 2.1 Introduction

The primary objective of the study was to determine whether a reduced (early) application regime using the fungicide azoxystrobin (Amistar) would effectively control bottom-rot of lettuce caused by the soil-borne pathogen *R. solani*.
The glasshouse trial was planned using standard fungicide treatments in comparison with experimental timings of azoxystrobin. The trial was sited in an experimental glasshouse with low temperature heating to insure frost protection. The glasshouse soil had been steam sterilised prior to the setting up the trial and was subsequently amended with a prepared inoculum of *R. solani* prior to commencement of the study in a bid to provide a stern test for the fungicide treatments under evaluation.

## 2.2 Materials and Methods

Crop and Cultivar

Protected Lettuce cv Wynona

Trial Design

The trial consisted of a randomised block with 8 treatments and 4 replicates. Each plot was comprised of $3m^2$ including 60 plants per plot (10 x 6). The outer plants in each plot formed a picture frame guard area and only the central 32 plants in each plot were used for assessments.

Treatments

| No. | Product | Active Ingredient | Rate (product/ha) | Application No. | Water volume (l/ha) |
|---|---|---|---|---|---|
| 1 | Untreated, uninoculated control | - | - | - | - |
| 2* | Untreated, inoculated control | - | - | - | - |
| 3* | Basilex [a] | tolclofos-methyl | 20kg/ha ($2g/m^2$) | 1 pre-planting application to the soil | 1000 |
| 4* | Terraclor Flo [a] | quintozene | 140 litres/ha ($14ml/m^2$) | 1 pre-planting application to the soil | 400 |
| 5* | Amistar | azoxystrobin | 1 litre/ha ($0.1ml/m^2$) | 1 pre-planting application to the soil | 300 |
| 6* | Amistar | azoxystrobin | 1 litre/ha ($0.1ml/m^2$) | 1 application to the foliage 7 days post-planting | 300 |
| 7* | Amistar | azoxystrobin | 1 litre/ha ($0.1ml/m^2$) | 2 applications 1st during propagation (*2-3 days before planting)* 2nd 7 days post-planting | 300 |
| 8* | Amistar | azoxystrobin | 1 litre/ha ($0.1ml/m^2$) | 2 applications<br>1st to soil pre-planting<br>2nd 7 days post-planting | 300 |

* *All plots with the exception of T1 (uninoculated control) were inoculated prior to planting with a virulent strain of R. solani previously isolated from lettuce exhibiting bottom-rot symptoms.*

[a] *Applied according to label recommendations*

***Note****: The rate of azoxystrobin used in previous studies[PC/FV 173] by ADAS on protected celery was 0.2ml product/$m^2$ and this equates to 2.0 litres product/ha. The SOLA rate recommended by Syngenta is 1.0 litres/ha and this is what was trialled in this study. A higher rate, whilst potentially improving efficacy, would potentially lead to further residue problems in a crop such as lettuce and therefore cannot be considered in this work.*

Crop Diary

Seeds sown into blocks: 8th October 2001

Established seedlings (3-4 leaf stage) planted out in glasshouse: 31st October 2001

Trial Harvested: 6th March 2002

| Spray Schedule | |
|---|---|
| Treatment | Date |
| Application in propagation (T7) | 29th October 2001 |
| Pre-plant soil application (T3, 4 and 5) | 30th October 2001 |
| 7-day post-planting application (T6, 7 and 8) | 7th November 2001 |

| Assessment Schedule | |
|---|---|
| Assessment | Date |
| Bottom rot assessment | 14th February 2002 |
| Bottom rot on 10 plants | 27th February 2002 |
| Disease assessment - % plants affected by *Botrytis* and *Sclerotinia* per plot | 6th March 2002 |
| Harvest assessments | 6th March 2002 |

Pathogen Introduction

A virulent isolate of *R. solani* isolated from lettuce was grown on sterilised artificial media containing vermiculite and corn meal. When the *R.solani* hyphae had successfully colonised all of the vermiculite/cornmeal media then the media was used to incorporate into the soil of each inoculated plot. The inoculum was incorporated into the top 15cm of soil at a rate of 5 litres per $3m^2$. The *Rhizoctonia* inoculum was incorporated 24hours prior to the pre-plant soil application of fungicides.

Fungicide Application

Treatments were applied using an Oxford Precision sprayer with a boom attachment operating at a pressure of 2 bars. Application rates detailed in the treatment table above were used and applied as described.

Disease Assessments

The inoculated control plants were monitored regularly for the establishment of *R.solani* on the stem base. Following full ground cover, when close inspection of the stem base was no longer possible, plots were destructively sampled using a minimum of 10 plants per plot and the bases of these plants were assessed for bottom-rot. Prior to harvest an overall disease assessment of 60 plants per plot was performed for the presence of other diseases but particularly – white rot (*Sclerotinia sclerotiorum)* and grey mould (*Botrytis cinerea)*. At crop maturity on 6th March 20 plants were randomly sampled from the centre of each plot and upturned and the bases were examined for the presence of bottom-rot caused by infection with *Rhizoctonia*.

Agronomic Assessments

The 20 harvested heads, which were assessed for *Rhizoctonia*, were also weighed to provide a bulked untrimmed weight and then trimmed to a marketable standard and re- weighed to provide a trimmed bulk plot weight.

To detect potential crop safety/phytotoxicity effects from any of the applied fungicide treatments a sub-sample of 5 disease-free lettuces was selected and these weighed before and after trimming.

Statistical Analysis

A statistical analysis of variance was performed on raw data using a Genstat programme. Within the tables of results are comments on the significance of data. These comments are based on the comparison between all the treatments including the control. The notation of significance in the tables is based on the following:

NS = Result not significant,
* = Significant result (Probability at 5 %),
** = Highly significant result (Probability at 1%),
*** = Very highly significant result (Probability at 0.1%).

Quality Assurance

The study described was undertaken in accordance with the guidelines for ‘Official Recognition’ of Efficacy Testing Organisations utilising EPPO guidelines where appropriate and company Standard Operating Procedures (SOP’s).
STC Certificate No. ORETO 110.
Date of Issue - 3 May 2001.
Expiry Date - 31 March 2006.

Archiving

All raw data and a copy of the bound summary report will be archived at the STC for a minimum of 5 years. Copies of relevant personnel records, Standard Operating Procedures (SOP’s) used in these studies will also be archived.

## 2.3 Results and Discussion

Inoculum of a pathogenic isolate of *Rhizoctonia solani*, previously collected from lettuce with bottom-rot symptoms, was bulked up as a maize meal culture in the laboratory and subsequently incorporated in all of the inoculated trial plots (T2-8). The progress of hyphal growth (fungal threads) in the surface soil was monitored by regular microscope examination of surface soil samples. *Rhizoctonia* was found to be present in the surface soil in the weeks following inoculation. However bottom-rot caused by this pathogen failed to establish in the inoculated untreated control plots during the course of the trial. A preliminary examination of lettuce on the 14th February, 14 weeks after planting out, showed that infection from *Rhizoctonia* was not present on the lower leaves or stem bases of any of the lettuce in the trial plants even where leaves were in contact with the soil surface. A destructive sample of 10 plants per plot (on the 27th February) provided an opportunity for more detailed examination of the bases of the lettuce. This assessment provided further confirmation that the applied *Rhizoctonia* inoculum had been unsuccessful in infecting the trial plants to cause characteristic symptoms of bottom-rot. This was despite the inclusion of the introduced pathogen to generate a high inoculum pressure. Towards the late stages of the trial (late January –early February) grey mould (*Botrytis cinerea*) and white rot (*Sclerotinia sclerotiorum*) caused mortality of occasional plants. It was decided therefore to extend the trial period by a further period to increase the likelihood of a late bottom-rot infection from *Rhizoctonia*. This extension also allowed extra time to secure data on other pathogens should the primary target pathogen fail to cause characteristic bottom-rot disease symptoms in the crop.

In the final weeks of the trial, whilst regular checks for the presence of *Rhizoctonia* bottom-rot progressed, both grey mould and white rot infection progressed significantly and ultimately affected the whole trial area and caused serious wilting and plant death. It was decided therefore to use the appearance of these two aggressive pathogens to extract as much data as possible from the trial. An assessment was performed on 6th March 2002 to determine the percentage of plants from each plot affected by both *Botrytis* and *Sclerotinia* infection. The results in Table 1 show that the distribution of both *Botrytis* and *Sclerotinia* was patchy within the trial.

Surprisingly, the untreated control plots were less affected by these two pathogens than some of the plots receiving fungicide treatment. However the results do indicate that Amistar (azoxystrobin), applied by various means in the 4 treatment programmes (T5 to 8) in this trial, was not sufficiently effective for the control of *Botrytis* and moderate to severe infection occurred within these treatments. Whilst data elsewhere has previously demonstrated that azoxystrobin, applied intensively, can effectively suppress *B. cinerea* it is not regarded as a specific effective botryticide. Control is usually achieved indirectly following effective suppression of other primary pathogens such as downy mildew (*Bremia lactucae*), thereby preventing wound/damage sites for colonisation by *B. cinerea*. This result, given the early treatment regime and absence of *Bremia*, is therefore not particularly surprising.

The results for white rot infection (*Sclerotinia*) were perhaps a little more encouraging. Treatment 5 (Amistar 1litre/ha as a pre-plant soil application) remained free from *Sclerotinia* and no plants exhibited white rot infection in this treatment. This result was comparable to Treatment 3 (Basilex 20kg/ha), which also remained unaffected by white rot infection. However, it should also be noted that Treatment 8 (Amistar 1litre/ha 1 soil application and 1 post planting), which also included a pre-plant soil application, Treatment 6 (Amistar 1 litre/ha one foliar application 7 days post-planting) and Treatment 7 (Amistar 1 litre/ha one application in propagation and 7 days post-planting) also had a relatively high level of *Sclerotinia* at harvest.
As this disease occurred in the trial area as a result of natural infection it is likely to have been variable in its distribution. We cannot therefore discount the possibility that in areas where the disease was apparently well-controlled infection was not present.

At crop maturity 20 heads of lettuce were harvested from the central area of each plot (Table 2). Many of these heads of lettuce were severely affected by rotting from both *Botrytis* and *Sclerotinia* infection. The results for mean untrimmed and trimmed head weights of the lettuce show significant differences between treatments. These differences are considered to be primarily a reflection of the affects of the severe basal and leaf rotting caused by infection with both *Botrytis* and *Sclerotinia* and not a result of colonisation by the introduced pathogen, *R. solani*.

As the primary yield assessment selected 20 lettuce heads at random it naturally included a proportion of the plants heavily infected with *Botrytis* and *Sclerotinia*. This data could not therefore be readily used to determine whether any of the applied fungicides had any detrimental ‘phytotoxic’ effects on crop growth in the absence of pathogens. Therefore, a further 5 disease-free lettuce sere selected from each plot, weighed, trimmed and re-weighed. The results are shown in Table 3. The results indicate that none of the treatments in the trial produced detrimental yield effects. There were no visible signs of phytotoxicity symptoms in any of the experimental plots during the course of the study.

**Table 1: The Mean Percentage of Lettuce Plants per Plot Affected by Grey Mould (*Botrytis cinerea*) and White Rot (*Sclerotinia sclerotiorum*)**

| No. | Treatment | % Plants affected by grey mould* | % Plants affected by white rot* |
|---|---|---|---|
| 1 | Untreated, uninoculated control | **7.2** (3.3) | **0.0** (0.0) |
| 2 | Untreated, inoculated control | **5.8** (2.0) | **6.34** (2.4) |
| 3 | Basilex 2g/sq.m. (1 pre-plant soil application) | **12.7** (10.7) | **0.0** (0.0) |
| 4 | Terraclor Flo 14ml/sq.m. (1 pre-plant soil application) | **3.6** (0.8) | **1.82** (0.4) |
| 5 | Amistar 1 litre/ha (1 pre-plant soil application) | **11.9** (5.8) | **0.0** (0.0) |
| 6 | Amistar 1 litre/ha (1 application to the foliage 7 days post-planting) | **23.4** (16.6) | **12.68** (4.95) |
| 7 | Amistar 1 litre/ha (2 applications 1st during propagation (*2-3 days before planting)* 2nd 7 days post-planting) | **31.2** (28.7) | **6.0** (2.4) |
| 8 | Amistar 1 litre/ha (2 applications, 1st to soil pre-planting, 2nd 7 days post-planting) | **14.5** (8.3) | **22.85** (15.3) |
| Significance: Between all Treatments | | * | *** |
| LSD 5% (24 df) | | **15.65** | **6.27** |

***** Results have been angle transformed for the analysis. The untransformed results are given in brackets for each treatment.

**Table 2: Mean Weight of Untrimmed and Trimmed Lettuce at Harvest**

| No. | Treatment | Untrimmed Lettuce Head wt(g)* | Trimmed Lettuce Head wt (g)* |
|---|---|---|---|
| 1 | Untreated, uninoculated control | 212.5 | 182.5 |
| 2 | Untreated, inoculated control | 164.0 | 157.0 |
| 3 | Basilex 2g/sq.m. (1 pre-plant soil application) | 178.5 | 157.0 |
| 4 | Terraclor Flo 14 ml/sq.m (1 pre-plant soil application) | 202.5 | 184.5 |
| 5 | Amistar 1 litre/ha (1 pre-plant soil application) | 190.5 | 185.5 |
| 6 | Amistar 1 litre/ha (1 application to the foliage 7 days post-planting) | 137.5 | 99.0 |
| 7 | Amistar 1 litre/ha (2 applications 1st during propagation (*2-3 days before planting)* 2nd 7 days post-planting) | 148.0 | 118.0 |
| 8 | Amistar 1 litre/ha (2 applications, 1st to soil pre-planting, 2nd 7 days post-planting) | 127.0 | 78.0 |
| Significance: Between all Treatments | | *** | *** |
| LSD 5% (24 df) | | 30.5 | 34.5 |

* Mean wt. of 20 harvested lettuce, including those infected with *Botrytis* & *Sclerotinia*.

**Table 3: Mean Weight of Healthy Heads of Untrimmed and Trimmed Lettuce at Harvest**

| No. | Treatment | Mean Untrimmed Head Wt.(g)* | Mean Trimmed Head Wt. (g)* |
|---|---|---|---|
| 1 | Untreated, uninoculated control | 216.0 | 192.0 |
| 2 | Untreated, inoculated control | 186.0 | 170.0 |
| 3 | Basilex 2g/sq. m.(1 pre-plant soil application) | 204.0 | 190.0 |
| 4 | Terraclor Flo 14 ml/sq.m (1 pre-plant soil application) | 202.0 | 186.0 |
| 5 | Amistar 1 litre/ha (1 pre-plant soil application) | 194.0 | 186.0 |
| 6 | Amistar 1 litre/ha (1 application to the foliage 7 days post-planting) | 186.0 | 168.0 |
| 7 | Amistar 1 litre/ha (2 applications 1st during propagation (*2-3 days before planting)* 2nd 7 days post-planting) | 182.0 | 162.0 |
| 8 | Amistar 1 litre/ha (2 applications, 1st to soil pre-planting, 2nd 7 days post-planting) | 222.0 | 200.0 |
| Significance: Between all Treatments | | NS | NS |
| LSD 5% (24 df) | | 38.0 | 40.0 |

* Mean of 5 healthy lettuce

### 2.4 Conclusions

It is difficult to draw firm conclusions from this study particularly as the primary target pathogen, *R. solani*, failed to establish in the trial area to infect the lettuce crop even after artificial inoculation with an aggressive isolate of the fungus.

The loss of quintozene (Terraclor) will undoubtedly impact heavily on glasshouse lettuce growers. This will be brought into even greater focus with the loss of MeBr in 2-3 years time. Also, whilst tolclosfos-methyl (Basilex) is still available a question remains over its overall value for two reasons. Firstly, as an acetyl-cholinesterase (OP) product, it has recently been evaluated as a component of a broader UK review and as a result its use on protected crops has been restricted significantly to protect operator safety. It can no longer be applied with knapsack or tractor-mounted sprayers and must instead be applied remotely (and this does NOT include application via the irrigation lines). The cost of remote gantry installations specifically for this purpose in the lettuce crop is likely to be prohibitive. Secondly, performance of the fungicide against *R. solani* has been brought into question by several growers following reports of poor control in the last 2-3 years. Fungicide insensitivity and/or resistance is suspected though this aspect requires further in-depth investigation before any firm conclusions can be drawn.

Glasshouse (winter) lettuce continues to be the focus of attention in pesticide surveillance/enforcement monitoring programmes and will continue to be so as regulators and pressure groups focus more heavily on multiple residue issues in food crops. The industry must therefore look to the longer-term and invest in R&D to develop alternative technologies which avoids the need for intensive pesticide inputs which might give rise to residues above the Limit of determination (LoD). High residues of azoxystrobin have already been found following a 4-spray programme on winter lettuce and the purpose of this study was to determine a minimal (early) use of the fungicide which would provide efficacy against *R. solani* but not leave residues deemed to be commercially unacceptable. Unfortunately the failure of the pathogen to establish in the test crop means that efficacy data using the applied early treatment regimes remains unavailable. However, the relatively poor results for *Botrytis* and, to some degree *Sclerotinia*, are not particularly encouraging.

It is concluded, therefore, that in the short-term at least, priority must continue to be given to establishing the relative efficacy of strobilurin and other fungicides, including azoxystrobin, against *Rhizoctonia*. In the longer-term, the lettuce industry must address the concerns of pressure-groups, including consumers, retailers and others, and seek alternative sustainable approaches to disease control in protected lettuce. This approach, by default, will go some way towards minimising residue levels, including multiple residues, in the crop.

**2.5 Technology Transfer**

Specific technology transfer events were not included in this short-term HDC contract and transfer of the information will be undertaken via the final report and in discussion forums with the glasshouse lettuce industry ie meetings of the Lettuce Technology Group.

**2.6 References**


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3. O'Neill, T M; Hilton, G & C Thornton (1999). Evaluation of fungicides for control of crater spot (*R. solani*) in protected celery. Tests of Agrochemicals & Cultivars 20 [Annals of Applied Biology Supplement], 12-13.


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