Grower Summary

FV/PE 410

Lettuce: Further development of 'Best Practice' for disease control in protected and outdoor crops

Annual 2013

Disclaimer

The results and conclusions in this report may be based on an investigation conducted over one year. Therefore, care must be taken with the interpretation of the results.

Use of pesticides

Only officially approved pesticides may be used in the UK. Approvals are normally granted only in relation to individual products and for specified uses. It is an offence to use non-approved products or to use approved products in a manner that does not comply with the statutory conditions of use, except where the crop or situation is the subject of an off-label extension of use.

Before using all pesticides check the approval status and conditions of use.

Read the label before use: use pesticides safely.

Further information

If you would like a copy of the full report, please email the HDC office (hdc@hdc.ahdb.org.uk), quoting your HDC number, alternatively contact the HDC at the address below.

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Project Leader:	Dr G M McPherson
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Industry Representative:	Geoffrey Smith, Mapleton Growers
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Headline

Using tank mixes of fungicides with different modes of action (often at half rates) can reduce the risk of residues at harvest and provide disease protection later in the season in protected and outdoor lettuce.

Background

Downy mildew (caused by the pathogen *Bremia lactucae)* is responsible for most losses in both outdoor and protected lettuce. Soil-borne diseases, such as *Sclerotina* and *Rhizoctonia* are also important and contribute to significant losses in some field and glasshouse crops, though interestingly the latter pathogen only appears to be problematic under protection. White mould (caused by *Sclerotinia* sp.*)* causes a severe head decay, especially near maturity and bottom rot (caused by *Rhizoctonia solani*) can also be very damaging though, as indicated, particularly in protected lettuce crops. Grey mould (caused by the pathogen *Botrytis cinerea*) is very often present on the oldest leaves and is usually removed during the normal harvest trimming, but in wet seasons heavy infections can reduce head weight as more leaves need to be removed.

The primary purpose of the project is to identify a range of novel fungicides and bio-control products with activity against the primary pathogens mentioned above but also taking due regard of any 'incidental' control of more minor sporadic pathogens. The main aim is to evaluate a series of spray programmes which provide broad activity on the crop which also provide a reduced risk of residues at harvest and which ensure minimal risk of resistance development.

Summary

The first outdoor (ADAS) and protected (STC) trials were completed in autumn 2012.
In the outdoor lettuce trial (Figure 1) there were 16 treatment programmes at four application timings and downy mildew was the prevalent disease with *Botrytis* affecting plants secondarily. Other pathogens, if present, were at low to trace levels only. The trial site was on a commercial farm so it was not realistic to artificially introduce the pathogens. There were significant differences between treatments for the control of downy mildew. Four of the treatment programmes looked particularly promising. Encouragingly, the most effective programmes for downy mildew control were based on products already approved for use on lettuce e.g. Amistar (azoxystrobin), Karamate (mancozeb), Signum (boscalid + pyraclostrobin), Fubol Gold (mancozeb + metalaxyl M), Revus (mandipropamid), Switch (cyprodinil + fludioxonil), Previcur Energy (fosetyl-aluminium + propamocarb hydrochloride) and two other, experimental coded products – F145 and F150. There were no significant

differences between treatment programmes for the control of *Botrytis*. There were no significant differences between treatment programmes for trimmed head weight after harvest. All pesticide residues remained below the limit of detection.

Figure 1. Autumn outdoor trial, Norfolk.

The protected trial was done in a glasshouse which had been used in the past for lettuce disease trials and which was known to have high levels of fungal pathogens, especially *Sclerotinia* and *Rhizoctonia,* already present in the soil. In this trial there were 12 treatment programmes at four application timings. The treatments included an untreated, an industry standard, four commercial programmes, four experimental programmes, a straight conventional experimental (coded) active and a straight biological experimental (coded) product.

Downy mildew and *Botrytis* infected the crop early and *Sclerotinia* developed at moderate to severe levels, therefore no artificial inoculation, as planned, was required. However, and somewhat surprisingly, the levels of *Rhizoctonia* recorded were low, given the previous cropping known problems with *Rhizoctonia* bottom rot and absence of soil sterilisation.

There were significant differences between treatments when assessed for downy mildew, *Sclerotinia* and the number of dead plants at each assessment date. There were no significant differences between treatments when assessed for *Botrytis* or *Rhizoctonia*. *Sclerotinia* was responsible for most of the plant deaths.

In terms of developing effective fungicide programmes to control such a broad range of target pathogens this initial trial has already demonstrated the challenges faced. For example, the treatments that performed best for control of Downy mildew did not perform well against *Sclerotinia* or *Botrytis*. The treatments that performed best for control of *Sclerotinia* were relatively poor for Downy mildew or *Botrytis* control and the treatments that were most effective against *Botrytis* were less effective against downy mildew or *Sclerotinia*. Therefore, in order to deliver a broad and effective treatment programme, it is appropriate to develop either tank mixes with different active ingredients (included at reduced rates to keep overall cost down) to maintain broad spectrum protection throughout or to tailor the fungicide programme based on climatic factors and relative to disease risk.

In this first study, the standard commercial programme (Amistar/Fubol Gold/Teldor/Revus) provided best control of downy mildew, but it performed poorly against *Botrytis* and below average against *Sclerotinia*. One of the commercial programmes (Fubol Gold/Signum/Switch/Serenade) provided the best overall control of the three pathogens present in this study, and three of the experimental programmes performed reasonably well against all diseases. Disease levels, predominantly *Sclerotinia*, in the glasshouse were so high by the end of the trial that most of the plants in each plot died or were severely diseased, leaving insufficient heads for samples to be taken for residue analyses.

Lab-based screening tests for active ingredients, including new SDHI's, with activity against downy mildew, *Botrytis*, *Rhizoctonia*, *Sclerotinia sclerotiorum* and *S. minor* identified a number of active ingredients capable of inhibiting pathogen growth. Many of the SDHIs provided good to excellent inhibition of *Rhizoctonia* and *Sclerotinia*, but a little surprisingly, were less effective against *Botrytis*. Some products inhibited *Botrytis* growth as well as *Rhizoctonia* (Rovral, iprodione) (Figure 2 (a) & (b)), and *Sclerotinia* (Octave, prochloraz) (Figure 2 (c) & (d)). HDC F158 inhibited all three pathogens, but was most effective against *S. minor*. Fungicides containing metalaxyl and dimethomorph provided good inhibition of *Phytophthora*, an oomycete organism used to represent *Bremia* which cannot be cultured *in vitro*. Infinito (fluopicolide + propamocarb hydrochloride) also inhibited oomycete growth well. Alternatives to metalaxyl are needed as resistance to this active in downy mildews is well documented.

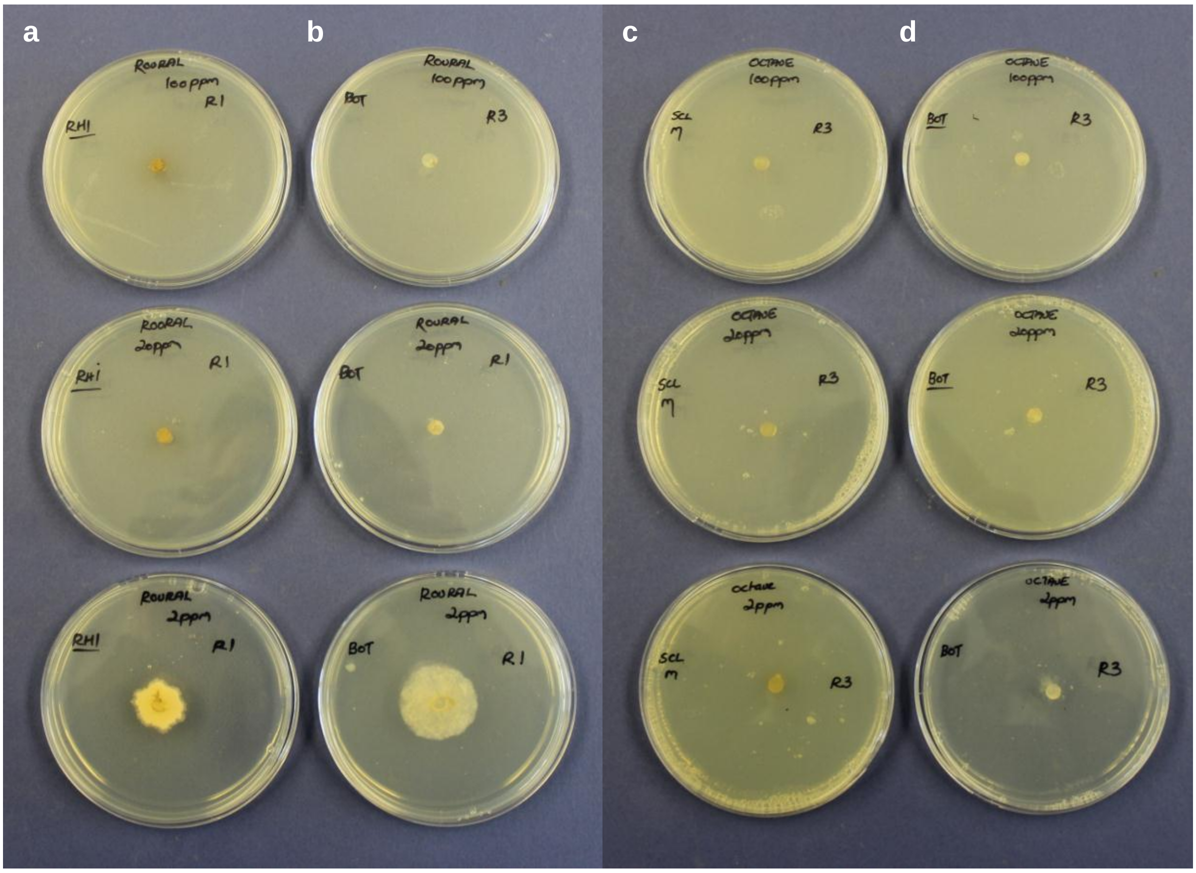

Figure 2. (a) Inhibition of growth of *Rhizoctonia* mycelium on agar plates by Rovral (iprodione). (b) Inhibition of growth of *Botrytis* mycelium on agar plates by Rovral (iprodione). (c) Inhibition of growth of *Sclerotinia* mycelium on agar plates by Octave (prochloraz). (d) Inhibition of growth of *Botrytis* mycelium on agar plates by Octave (prochloraz). The highest concentration of product (100ppm) is at the top of the photograph, followed by 20ppm in the centre and the lowest concentration (2ppm) is at the bottom.

A commercial crop of iceberg lettuce of cultivar Robinson was used for the spring outdoor trial. Pathogen infection was by natural occurrence, and the likelihood of infection was increased by using a field with a history of *Sclerotinia* and crop covers during the early part of the season because of the cold spring. There were 16 treatments combining tank mixes and single product applications. Four post-planting treatment applications were made. There was a high incidence, and moderate severity of *Botrytis* in the trial, and low levels of *Sclerotinia*. No downy mildew or ringspot was recorded in this trial. There was significantly more *Botrytis* in treatments that received Signum at the first application. *Sclerotinia* disease levels were low and no treatment differences were significant. Treatment 10, which contained products for downy mildew control at each application and HDC F151 in a tank mix at the second application, had a significantly lower incidence of *Botrytis* and a lower *Botrytis* severity than all the other treatments. At harvest, levels of *Botrytis* were very close to causing losses from extra trimming of the heads. This experiment suggests that good control of *Botrytis* may be difficult to achieve, though there may be scope to maintain protection by using suitable fungicides at the fourth application. No pesticide residues were detected in any of the samples and all remained below the limit of detection.

In the spring protected trial there were 12 treatment programmes including an untreated control (Figure 3). Four post-planting application timings were planned, but only three could be made as the crop matured quickly. The treatments included an untreated, an industry standard, two commercial programmes, four experimental commercial programmes and four experimental (non commercial) programmes. Many of the programmes included Amistar to control *Rhizoctonia* so that they could be compared to the use of Basilex pre-planting which was used in the industry standard treatment. The programmes in this trial were designed to see how late fungicide applications could be made before harvest without incurring residue exceedances. Currently the majority of the fungicide applications are made in the first three to four weeks after planting, exposing the crop to disease infections later on which could make heads unmarketable. Growers are cautious of applying fungicides close to harvest because they do not wish to exceed maximum residue limits (MRLs). These programmes were designed to space out the number of applications to give better control of fungal pathogens from planting to harvest and, by using half rates and tank mixes thus trying to minimise residues at harvest. The crop matured faster than expected so the final treatment applications could not be applied. The crop had to be harvested before the minimum recommended harvest intervals had been reached for many of the products. This enabled data to be gathered on whether reducing application rates also reduced residues at harvest.

Figure 3. Spring protected trial at STC showing plots in the foreground that suffered from severe *Sclerotinia* and *Rhizoctonia* infections.

The variety used was a butterhead lettuce of cultivar Tahamata. To increase the chances of infection by the target pathogens, the trial was done in a glasshouse which had been used in the past for lettuce disease trials and it was known to have high levels of fungal pathogens, especially *Sclerotinia*, already present in the soil. *Rhizoctonia* was artificially introduced by inoculating the soil pre-planting. *Bremia lactucae* was artificially inoculated by applying a spore suspension to six plants per plot on two occasions during the trial. However, neither inoculation with *Bremia lactucae* worked. *Botrytis cinerea* occurred naturally, without artificial infection.

Some treatment programmes included pre-planting applications. The first foliar applications were carried out 2-3 days post-planting, with other applications made at 14 day intervals.

No *Bremia lactucae* was observed in the trial. There were quite high levels of *Botrytis* and moderate levels of *Rhizoctonia* and *Sclerotinia*. The presence of *Botrytis* was not consistent from one assessment to the next, and although there were significant differences between treatments in the first and last assessments, these differences were not repeated in both assessments. Botrytis incidence in the untreated control was low, but may have been masked by the high levels of *Rhizoctonia* and *Sclerotinia* present. There were significant differences between the levels of *Rhizoctonia* and *Sclerotinia* at all assessments and these differences remained fairly consistent from one assessment to the next. There were low levels of bacterial rot to the lower leaves recorded at harvest.

Some low levels of pesticide residues were recorded at the end of the trial, but these were below the MRLs with the exception of HDC F152, which has an MRL in lettuce of 0.01 mg/kg anyway (the lowest limit of detection). Considering the crop was cut before the minimum harvest interval, the policy of using half rates in tank mixes has meant that products could potentially (subject to appropriate authorisation) be applied closer to harvest when used at lower rates, without appearing to compromise efficacy.

Treatment 3 (Commercial) – (Contans/Amistar/Fubol Gold/Paraat), treatment 6 (experimental commercial tank mixes) - (Amistar + Fubol Gold/Signum + Switch/Paraat + Rovral), and treatment 7 (experimental commercial tank mixes) - (Amistar + Fubol Gold/ Signum + Paraat) resulted in significantly fewer dead plants at the end of the trial than the industry standard. There were differences in the disease severity between these treatments and the standard, but these were not significant. The mean head weight for these treatments was slightly below that recorded for the standard programme, but not significantly so. The number of marketable heads was significantly greater in these treatments than in the standard (Figure 4).

All three programmes had three products in common: Amistar, Fubol Gold and Paraat. Interestingly in plate tests azoxystrobin, the active ingredient of Amistar, did not provide good inhibition of *Rhizoctonia* and *Sclerotinia*, but it is known that some products provide additional activity *in vivo* e.g. the ‘turning on’ of host defence systems or leaf greening and these effects are not measurable during *in vitro* studies. Contans, which provided good inhibition of *Sclerotinia* in *in vitro* tests, may have helped control *Sclerotinia* in Treatment 3 and Signum, which provided good inhibition of *Rhizoctonia* and *Sclerotinia* in *in vitro* tests, may have helped to control these diseases in treatments 6 and 7, but it was not applied until later in the treatment programmes, as was Rovral in treatment 6, which does not explain why very low levels of these pathogens were recorded in earlier assessments. Treatment 7 only received two treatment applications in total, and yet was one of the best performing treatments. It seems possible that there may be an interaction between Amistar and Fubol Gold, when made as an early application, which is controlling these pathogens more effectively. These results suggest that by using these products in the effective tank mixes at the correct timings, it may not be necessary to use Basilex as a pre-planting treatment. As no *Bremia* infected the trial it is not possible to evaluate the performance of Fubol Gold, although in the field trial it performed well at controlling the pathogen in treatment programmes that also included Amistar. Such mixtures or alternating programmes will continue to be important to reduce the risk of resistance in the *Bremia* population. Paraat was also used in the field trial programmes and provided quite good control of *Bremia*, although not as good as Fubol Gold.

Figure 4. Spring 2013 protected trial: standard treatment (left) compared to treatment 7 (right). Photos taken at harvest and heads turned over to show condition of lower leaves.

None of the experimental programmes performed as well as the standard or any of the commercial programmes. Whilst this is disappointing, it does suggest that it may be possible to control these important pathogens using existing approved products available to growers without necessarily waiting for new products to be registered and approved.

Knowledge acquired from the first year trials will be used to devise more specific programmes to target these pathogens and refine the treatment applications in the final year of the project.

Financial Benefits

Some useful initial benefits of the project work are the indication that a reduced number of treatment applications could be made per crop by improving timings of application. The use of effective tank mixes of products at reduced rates means that disease control can be maintained and products could potentially be applied closer to harvest. This could result in cost reductions for products and application time. As fungicides could also be applied closer to harvest, crop losses could also be reduced therefore increasing the economic yield. Further work would be required to ensure such uses stay within the regulatory framework.

Action Points

- Design specific spray programmes, using already approved products, based on:
  - the likely risk of pathogens at that time of year
  - the type/cultivar of lettuce grown
  - the cropping history of the site
- There is potential to use reduced application rates of products either in tank mixes or as alternating spray programmes to target 2 or more pathogens simultaneously. Prior to doing this it will be important to check the regulatory situation especially in relation to applications closer to harvest as several products have specific restrictions relating to latest time of application.
- Apply products at timings likely to have the most effect on prevalent pathogens.