Grower Summary

FV 391

Carrots: Improving the management & control of cavity spot

Final 2014

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.

HDC is a division of the Agriculture and Horticulture Development Board.

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Project Leader:	Dr P Gladders, ADAS UK Ltd[1]
Contractor/(s):	ADAS, STC Ltd
Industry Representative:	Keith Mawer, Strawson Ltd, Bilsthorpe, Notts
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Further information

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

HDC,
AHDB
Stoneleigh Park
Kenilworth
Warwickshire
CV8 2TL

Tel – 0247 669 2051

[1] Dr Gladders retired from ADAS on 5th December 2013. Dr Tim O'Neill and Tim Boor completed the project.

GROWER SUMMARY

Headline

- SL567A reduced carrot cavity spot in two out of four trials where the disease occurred at a high incidence; Limex soil incorporation was effective at one of these sites; no better treatments were identified.
- The level of cavity spot reduction achieved with SL567A was not related to speed of Metalaxyl-M degradation; good control was observed at a site with slow degradation and also at a site with fast degradation.

Background

Carrot cavity spot remains one of the most important diseases of carrots (Koike *et al*., 2007), capable of causing complete loss in parts or even whole crops. Financial losses are particularly high when overwintered crops are lost. Management of the disease has relied on the use of partially resistant or tolerant varieties and metalaxyl-M fungicide treatment early in the life of the crop. Recent HDC projects (FV 353, CP 46) have improved understanding of the pathogen and indicate that the main pathogen *Pythium violae* is able to utilise a wide range of crop and weed hosts. Whilst long rotations (e.g. 1 in 6) have benefited carrot production by reducing the risk of damage from various pests and pathogens, such methods have not effectively reduced cavity spot. Disease development can be strongly influenced by rainfall (soil moisture) and some quantitative data based on irrigation experiments is available from FV 353. Whilst this has helped explain variation in disease development, weather conditions are outside grower control so fungicide treatment remains the main tool that growers can use to counteract infection triggered by rainfall events. Metalaxyl-M has served the industry well for many years though its efficacy has been gradually eroded and this is considered, in part at least, to have occurred as a result of enhanced degradation of the active molecule at some grower sites. As the industry is dependent on a single fungicide with a single site mode of action, the sustainability of this treatment is a major concern. The extent to which fields in carrot production are affected by enhanced degradation is unknown. A soil test would be of interest to growers as a chargeable service if enhanced soil degradation can be shown to affect field performance of metalaxyl-M.

New fungicide active ingredients, particularly those used for potato late blight (*Phytophthora infestans*) or downy mildew were considered candidates for cavity spot control. Screening of new products (mainly strobilurin chemistry) was last reported in 2001 in FV 5f (Pettit *et al*., 2001). New candidate active ingredients and products are now available from various manufacturers including Bayer CropScience and BASF. Treatment impacts on *Pythium violae* were appraised during the growing season of year 2 of the project using a quantitative molecular PCR assay; methodology which was developed earlier in FV 353. Measures of pathogen activity in relation to treatments were undertaken in collaboration with the University of Warwick.

The project also evaluated non-fungicidal treatments including biological control agents, along with soil amendments and calcium treatments. The latter provided some useful activity in pot and field tests in FV 5f and have been used successfully against clubroot (*Plasmodiophora brassicae*) in vegetable brassicas (Defra project HH3227TFV, 2007); calcium applications can be made immediately prior to sowing (e.g. as Limex). The effects of calcium are complex, extending beyond changes in soil pH to modification of soil microflora and direct effects on the host plant. Previously, Scaife *et al.,* 1983 reported decreased incidence of cavity spot when soil exchangeable calcium exceeded 8 milliequivalents per 100 g soil.

The use of varieties with resistance to cavity spot is well-established in the industry. However, resistance is incomplete and therefore additional control measures, particularly fungicides, are still used. Whilst fungicide evaluation has been undertaken on more susceptible varieties, the benefits on the most resistant varieties also needs to be established. In the future it may be possible to refine the range of measures that are required to control cavity spot at field level.

The overall aim of this project was to improve the management and control of cavity spot. Specific objectives were:

1. To evaluate new fungicides and biological treatments with potential to control *Pythium* species in soil;
2. To establish optimum application rates and timings for the most promising new products;
3. To determine the contribution of pre-planting calcium applications for cavity spot control;
4. To determine the prevalence of enhanced degradation of metalaxyl-M in carrot growing areas.

Summary

This project comprised two replicated field experiments (Retford, Notts and STC, Cawood, Yorks) per year over 3 years. The experiments were done using the susceptible variety Chantenay at the Notts site and a confidential susceptible variety at the Yorks site. The aim was to evaluate new fungicides and biological products for the control of carrot cavity spot using both field and laboratory based studies. In addition, soils were tested from carrot crops for enhanced degradation of metalaxyl-M. The effects of pre-sowing calcium treatments (such as Limex or Perlka) were also investigated (Table 1).

In year 1 (2011), cavity spot levels were low and no significant treatment differences in incidence or yield were observed in the two field experiments. However, good comparisons were achieved in years 2 and 3 with disease levels in the untreated controls between 18% and 64%.

In 2012 15 treatments were examined in comparison with the untreated control. The standard fungicide metalaxyl-M (SL567A) was the most effective fungicide at the Notts site where cavity spot incidence was reduced by 35%. None of the experimental products provided significant control, although there was a trend for slight reductions in cavity spot incidence for some treatments. Limex (15 t/ha) provided significant control at the Notts site, decreasing cavity spot incidence by 19%. There was no significant control of cavity spot with any of the treatments at the Yorks site.

Table 1. Effects of novel fungicides, Limex and Perlka in comparison with SL567A on the incidence of cavity spot in 2012.

				Cavity spot incidence (% of carrots affected)	
	7 Days Pre-drilling	4-6 weeks after drilling	4-6 weeks later	Notts	Yorks
1	Untreated	Untreated	Untreated	55	65
2		SL567A (1.3 L/ha)	-	20	55
3		SL567A (0.65 L/ha)	SL567A (0.65 L/ha)	19	60
4		HDC F50	-	51	65
5		HDC F50	HDC F50	53	63
6	HDC F51	-	-	40	68
7	HDC F51	HDC F51		43	62
8		HDC F52		55	78
9		HDC F52	HDC F52	49	69
10		HDC F53		47	55
11		HDC F53	HDC F53	42	62
12	HDC F125	HDC F125	HDC F125	51	49
13	Limex 5 t/ha	-	-	48	68
14	Limex 10 t/ha	-	-	37	60
15	Limex 15 t/ha	-	-	34	60
16	Perlka 400 kg/ha	-	-	74	60
Fpr	-	-	-	<0.001	0.349
SED	-	-	-	9.5	9.28
LSD	-	-	-	19	18.64

In 2013, 16 treatments were examined in comparison with an untreated control utilising eight conventional fungicides (Nativo 75WG, Rudis, SL567A, Switch, HDC F53, HDC F50, HDC F52, HDC F167), one biofungicide (HDC F166) and Calcium treatment (Limex). Products were applied either 7 days pre-drilling and / or up to three times post – drilling; programmes consisted of 1-3 applications (Table 2).

Cavity spot was significantly reduced at one site by SL567A only, SL567A followed by Switch and by Limex applied pre-drilling (Tr15-17). These treatments reduced the incidence of affected carrots by 67-75%. No evidence was found that two half-rate post drilling applications of SL567A or any of the test fungicides was better than one full rate application. There were trends towards disease reduction with several treatments including HDC F50, HDC F52 and HDC F53. A combined treatment of Limex pre-drilling and SL567A post drilling was no better than either treatment alone. Increasing the rate of Limex application from 10 to 15 t/ha did not increase disease control at the Notts site in terms of disease incidence, however there was a trend for increased control in terms of disease severity; there was also a trend towards reduced disease at the higher rate of Limex at the Yorks site. There were significant effects upon pH in the Limex treatments at the later assessments in both the Yorks and the Notts trial, with this being a clearer dose effect at the later assessment. Also it was found that the higher Limex applications resulted in a higher amount of available calcium, Figs 1 and 2. At the Yorks site, levels of cavity spot were higher (56% untreated) and no treatment reduced the disease.

Over the entire project, six field trials were conducted, with significant treatment effects identified in two of these trials. The standard fungicide metalaxyl-M (SL567A) showed trends to have the greatest level of efficacy in 2012, although control was not significantly different from the 10 and 15 t/ha rate of Limex. In 2013 there were no significant differences between the Limex and metalaxyl-M treatments. When assessing the disease severity data across all sites and years of the project, Limex effects and the effect of SL567A were only found to have small effects on disease severity overall, with this result thought to be due to the low levels of disease severity observed throughout. The experimental fungicides were not found to have a significant influence upon cavity spot incidence in the first two years, although there were trends for useful control in 2013 when rates of products were increased. It is worth considering that when the original work with metalaxyl-M was undertaken in the early 1980s the rate of use found to be efficacious was 8 x the rate used on potatoes for blight control (McPherson, pers com). It is therefore important to consider much higher fungicide rates of use than normal for cavity spot control, though it is important to note that any increase in rate of application could have an impact on future regulatory approval. Across the project not all soil amendments resulted in positive results, with Perlka resulting in significantly higher cavity spot incidence than the untreated control. Perlka was dropped in year 3 of the project.

Table 2. Effects of novel experimental fungicides, Switch, Nativo 75WG, Rudis and Limex in comparison with SL567A on the incidence of cavity spot in 2013.

	Application timing				Cavity spot incidence (% of carrots affected)	
	7 Days Pre-drilling	4-6 weeks after drilling	4-6 weeks later	4 weeks later	Notts	Yorks
1	Untreated	-	-	-	19	55.8
2		SL567A (1.3 L/ha)	-	-	8	44
3		SL567A (0.65 L/ha)	SL567A (0.65 L/ha)	-	6.2	36
4		SL567A (1.3 L/ha)	Switch 0.8 L/ha	Switch 0.8 L/ha	4.8	40
5		HDC F53	-	-	12	49
6		HDC F53	HDC F53	-	15.5	47
7		HDC F53	Nativo 75WG 0.3 L/ha	Nativo 75WG 0.3 L/ha	18.5	62.5
8		HDC F53	Nativo 75WG 0.3 L/ha +Rudis 0.4 L/ha	Nativo 75WG 0.3 L/ha +Rudis 0.4 L/ha	20.5	65
9		HDC F50	-	-	18	46.5
10		HDC F50	HDC F50	-	7.8	57.5
11		HDC F52	-	-	8.5	61.5
12		HDC F52	HDC F52	-	14	44.5
13	HDC F166	HDC F166	-	-	18.5	44.5
14	HDC F167	HDC F167	-	-	15.8	56
15	Limex 10 t/ha		-	-	6	53
16	Limex 15 t/ha	-	-	-	5	36
17	Limex 10 t/ha	SL567A (1.3 L/ha)	-	-	6	33.5
	Fpr				0.08	0.138
	SED				6.22	11.41
	LSD				12.5	22.9

Alternaria control

A number of treatments at the Notts site were found to provide significant control of alternaria blight (*Alternaria dauci*) compared to the untreated (25% leaf area affected). HDC F53 applied 4 weeks post drilling resulted in 7% leaf area affected, with clear improvements in control observed as additional products were added to HDC F53 within treatment programmes. HDC F53 followed by Nativo 75WG and Rudis 4 and 8 weeks later was the most effective treatment overall (0.1% leaf area affected). The standard, SL567A, applied either once or twice post drilling, did not provide significant control of alternaria (13.7-15.9%

leaf area affected), however where SL567A was followed by Switch twice, disease severity was reduced significantly (9.7% leaf area affected).

Tests for enhanced degradation of metalaxyl-M

Soils were tested for enhanced degradation of metalaxyl-M throughout the project. A number of samples were collected from commercial carrot growers as well as the Notts and Yorks trial sites. In 2011, soil from 32 fields (including the two fungicide trial sites) was assessed for the persistence of metalaxyl-M. In 15 soils the half-life was less than 10 days, a breakdown rate previously associated with control failure. In 12 soils the half-life was greater than 20 days. The remaining 5 soils fell between 10 and 20 days. There was some evidence of correlation between half-life and pH with half-life appearing to diminish with increasing pH. The effect of organic matter was weak. In 2012 no soils sampled degraded in less than 10 days, but nine soils degraded between 10 and 13 days. Metalaxyl-M control is unlikely to be effective in these situations. In eleven soils the half-life was greater than 20 days where control is likely to be more effective with the greater persistence. In 2013 soils from the two trial sites was tested. Both soils were found to have a half-life of less than 10 days, a break down rate which would be associated with disease control failures.

Measurement of Pythium in soil

During the 2012 experiments a soil test was completed across all experimental plots at both sites to detect for the presence or absence of *P. violae* DNA. The test demonstrated promising signs of detection. For example, at Notts all of the untreated and HDC F125 plots gave positive results for the detection of *P. violae* DNA, and these also had the highest cavity spot incidence. However some of the other results were not consistent with cavity spot disease. At the Yorks site, none of the plots tested positive for *P. violae* DNA, yet a high incidence of cavity spot was recorded in many plots. More work is needed in the future to refine this technique.

Novel fungicides

In 2013, a laboratory agar plate test at ADAS Boxworth examined activity of five novel fungicides (HDC F168, HDC F169, HDC F170, HDC F171 and HDC F172) for reduction of mycelial growth of three isolates of *P. violae* in comparison with SL567A. SL567A was the most effective at inhibiting mycelial growth, which compared well to the field work. Promising results were produced by HDC F172 which was identified as the most effective experimental product. This product has not been evaluated in the field yet.

Financial Benefits

This study identified no alternative candidates to SL567A as a chemical control for cavity spot, however Limex soil amendment was found to be of considerable benefit. Limex might be the preferred treatment on sites where a history of enhanced degradation is already known as well as on sites where pH is not currently very high. The cost of 10 t/ha of Limex (delivered and applied) can vary between £150/ha to in excess of £300/ha depending on distance from British Sugar factories (Cogman, pers comm). With the costs of SL567A approaching £300/ha delivered and applied, Limex could be a viable alternative for a number of growers. The financial benefits are likely to be greatest where the treatment application timing is optimized. For chemical treatments, previous studies have shown, this should be post-emergence to moist soil no later than 6 weeks after sowing.

Action Points for growers

1. Limex can provide good control of cavity spot and may be an effective alternative treatment to Metalaxyl-M.
2. No benefit was identified from applying products at half rate at more spray timings.
3. Alternaria was significantly reduced by a number of treatment programmes, with the most effective programme containing HDC F53 4 weeks post drilling followed by Nativo 75WG and Rudis 4 and 8 weeks later.