Grower Summary

FV 377

Onions: improving risk assessment for free-living nematodes

Final 2012

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Further information

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Headline

Pot experiments indicate that populations of needle, root lesion, stubby root and stunt/spiral nematodes well above current guideline thresholds have no effect on onion growth, suggesting that significant savings can be made on nematicide use.

Background

Free-living nematodes are important pests of onions but chemical control options are limited. Therefore it is becoming increasingly important to be able to determine where the crop can be grown without the risk of nematode damage.

The risk from free-living nematodes (FLN) can be assessed by considering field history, previous cropping and representative soil sampling. However, there is little information available on those free-living nematodes that are most damaging to onions and at what level they pose a risk. In addition, there is some confusion over when is best to sample for free-living nematodes due to their potential to move up and down the soil profile.

This project aims to improve risk assessment for free-living nematodes in onions by studying the following:

1. *Infestation levels:* The first and most fundamental component of risk assessment is to understand the nematode infestation level that justifies treatment. Current guideline thresholds for onions have little scientific basis and are based on anecdotal information. Work is required to develop robust thresholds quoted as either numbers per volume or weight of soil.

2. *Historical data from soil analysis:* ADAS Pest Evaluation Services (PES) have several thousand records of free-living nematode analyses between 2000 and 2010. These data will be interrogated to indicate the relative abundance of different nematode groups, their numbers, proportion of samples over threshold and any trends in nematode numbers over a 10 year period.

3. *Soil sampling:* There is a lack of confidence in soil sampling to predict risk from nematodes as they may move up and down the soil profile in response to soil moisture and temperature. This could affect estimates of numbers depending upon when samples are taken and to what depth. Work will determine the optimum soil moisture and temperature ranges at which to sample to get the best estimate of pest numbers. In addition the impact of soil cultivation on nematode numbers will be investigated.

4. *Alternative products*: The final aspect of the project will evaluate potential alternative products for control of free-living nematodes. Alternative chemical control options such as HDCI 036 are available but are not approved for this use on onions.

The specific objectives of this project are listed below:

1. To measure the effect of different populations of needle (*Longidorus* spp.), stubby root (*Trichodorus/Paratrichodorus* spp.), stunt/spiral (*Tylenchorynchus/ Helicotylenchus/Rotylenchus* spp.) and root lesion (*Pratylenchus* spp.) nematodes on the growth of onions, to determine which nematode species are potentially most damaging.
2. To analyse historical sampling data to provide background information on field populations of different free-living nematode groups.
3. To monitor the vertical distribution of nematodes in relation to soil moisture, temperature and before and after cultivation in order to recommend an optimum period and depth for soil sampling.
4. To undertake pot experiments to test the effectiveness of a selection of nematicides and biopesticides on the control of free living nematodes

In future, protecting crops from free-living nematode damage will become increasingly reliant on integrated strategies that combine cultural and chemical control. Robust risk assessment will be fundamental to the success of such IPM programmes.
In year one of this project, objectives 1 and 3 were started and objective 2 completed. In year 2 objectives 1, 3 and 4 were completed.

Summary

Objective 1: Pot experiments to establish the most damaging nematode species to onions

A range of populations of needle, root lesion, stubby root, stunt/spiral and needle nematodes were created by soil dilution. The root lesion, stubby root and stunt/spiral nematodes were studied in year 1 and the needle nematodes in year 2. The nematode populations were created by mixing soil infested with nematodes with the same soil that has been sterilised. A total of 30 target populations was created for each nematode group (Table 1). The table also shows the current provisional threshold at which nematicide treatment is advised. These appear to be based on anecdotal evidence only and therefore are of limited value when interpreting the results of FLN analysis.

Table 1. Target nematode populations for pot experiments and provisional thresholds.

Nematode group	Provisional threshold (nematodes/litre soil)	Target population range (nematodes/litre soil)
Needle	50	0 – 1,305
Root lesion	2,500	0 – 3,350
Stubby root	200	0 – 6,902
Stunt/spiral	10,000	0 – 11,600

The target populations were made up in 1.5 L pots and sown with 20 onion seeds (Variety Vision). Pots were maintained in a polythene tunnel and watered as necessary.
Nematode numbers were assessed to determine how the actual populations compared with the target populations. To assess the impact of nematode populations on onion growth seedling emergence was monitored daily and onion dry matter yield measured.
Nematode counts showed that the actual populations were very close to the target population. However, there was no obvious effect of nematode population on onion growth and yield. This result suggests that current guideline thresholds for free-living nematodes are far too conservative and that the crop can tolerate much higher populations of these pests. Also, potentially nematicide used in onions can be significantly reduced which would greatly improve crop profitability.

The results for root lesion and stunt/spiral nematodes were supported by additional work undertaken using a different methodology which are reported in Appendix 1.

Objective 2: Analysis of historic sampling data

A total of 11,733 records for free-living nematode samples was extracted from the PES database for the period 31 October 2000 until 23 September 2010. Summaries were provided on the range of nematode groups and field populations in relation to existing guideline thresholds. The aim was to determine the most frequently recovered nematodes, their numbers, how these compared with the current guideline thresholds and whether there have been any obvious trends in nematode counts over the 10 year period.

The most frequently extracted nematodes between 2000 and 2010 were stunt/spiral nematodes followed by root lesion nematodes, stubby root nematodes, needle nematodes, cyst juveniles, dagger nematodes, stem nematodes and root knot nematodes. Both stem nematode and root knot nematode are both potential important pests of onions but were recovered from less than 1% of samples. There were no clear trends in nematode numbers

between years and no indication that the risk from free-living nematodes is increasing or decreasing. Most nematodes were recovered least frequently in 2007 and most frequently in 2004. Stubby root nematodes were the main exception to these trends as they were least common in 2006 and most common in 2003.

The maximum nematode count was 33,975 stunt spiral nematodes/L soil. The next highest individual nematode counts were for stem nematode (20,325/L soil) and root knot nematodes (15,750/L soil). These nematodes were rarely recovered from soil as previously discussed but when present could be found in very high numbers.

The proportion of nematode counts above threshold for individual groups gives an indication of the potential crop area likely to be treated with a nematicide. There is some evidence to suggest that guideline thresholds for stubby root nematodes are too conservative at 200/L soil (Ellis, unpublished data) and that 1000/L soil is a more realistic figure. The impact of increasing the threshold for stubby root nematodes was also considered.

Stubby root nematodes are most likely to exceed current threshold levels. Between 2000 and 2010, 41.5% of samples contained numbers of stubby root nematodes above the 200/L threshold and so would have justified nematicide treatment. If the stubby root nematode threshold is increased to 1000/L soil, as suggested by previous work, then only 9.4% of samples would have exceeded this level. For other nematode groups for which there are guideline thresholds, nematicide treatment would have been justified in 14.1% of samples with needle nematodes, 3.5% of samples with root lesion nematodes and less than 1% of samples with dagger and stunt/spiral nematodes. Therefore, stubby root nematodes are the most important nematode group in determining nematicide use, particularly if the 200/L threshold is retained. If thresholds are far too conservative, as suggested by the pot experiments undertaken as part of objective 1, then there is considerable potential to reduce nematicide treatment in the onion crop.

Objective 3: Monitoring vertical distribution of free-living nematodes and numbers pre and post cultivation.

At three sites regular soil samples were taken at monthly intervals from small plots and the vertical distribution of nematode numbers related to detailed data on soil moisture and soil temperature. These samples were taken from September 2010 until August 2011. The three sites were as below:

1. West Dereham, Norfolk, (sandy loam), field Barshall I in sugar beet

2. Euximoor, Christchurch, Cambs. (silt) field Euximoor 4 in onions
3. Chatteris. (organic) Field Pickle Fen 1 in potatoes

A datalogger (Adcon soil moisture and temperature monitoring system) was used to measure soil temperature (ºC) and soil moisture (% water by volume) at a range of soil depths from 10 – 60 cm. A single probe was used to take measurements at each depth. A total of 10 cores was taken around a semi-circle of radius approximately 10 m centred on the datalogger. The data were used to investigate nematode migration patterns in relation to moisture and temperature in order to determine the optimum conditions for soil sampling to give the best estimate of nematode risk.

The impact of soil cultivation on nematode numbers (achieved by sampling pre- and post-sampling) was assessed at five sites.

1. Swaffham Prior 1, Cambridgeshire
2. Swaffham Prior 2, Cambridgeshire
3. Chatteris, Cambridgeshire
4. Upwell, Norfolk
5. Littleport, Cambridgeshire.

At all monitoring sites soil temperature varied between 1ºC and 16ºC with lowest temperatures in December 2010 and the highest in September 2010 or August 2011. In general, there was little difference in mean soil temperature between the six soil depths. Soil moisture tended to be more variable than temperature and varied between a minimum of approximately 15% and maximum of 35% moisture by volume. There was a maximum difference of approximately 10-15% moisture by volume between different soil depths.
In general results showed that numbers of all nematode groups recorded at the three sites decreased with increasing soil depth. In the majority of cases most nematodes were found at 0-20 cm.

There was a trend for a positive relationship between soil temperature and nematode numbers extracted. Numbers extracted tended to increase with increasing temperature within the range of 1-16ºC. In contrast to soil temperature data, there was generally a trend for a negative relationship between soil moisture and nematode numbers. Numbers decreased with increasing soil moisture within the range of 15-35% moisture by volume. Equations generated to describe the relationship between nematodes and soil temperature and

moisture could not be relied upon to give an accurate indication of nematode numbers at a particular value of soil temperature or moisture.

In general, there was little effect of cultivation on nematode numbers.

Objective 4: Pot experiment to test the effectiveness of a selection of nematicides and biopesticides on the control of free living nematodes

A pot experiment was set up to compare the efficacy of six novel products, three nematicide standards and an untreated control against free-living nematodes (Table 2).

Table 2. Products evaluated for control of nematodes and their effect on total numbers.

Treatment number	Product	Active ingredient	Rate/unit area	Total nematodes/L soil
1	Untreated control	-	-	396
2	Vydate 10G	Oxamyl 10% w/w	2000 g ai/ha	317
3	Vydate 10G	Oxamyl 10% w/w	4000 g ai/ha	554
4	HDCI 036	Confidential	30 kg/ha	138
5	HDCI 037	Confidential	1kg/5L water	325
6	HDCI 038	Confidential	2000 g ai/ha	342
7	Sesamin EC	Sesame oil 70% g/l	10 L/ha	496
8	Sesamin EC	Sesame oil 70% g/l	20 L/ha	412
9	Biofence meal	De-fatted mustard seed meal	300 g/m^2	304
10	Biofence granules	De-fatted mustard seed meal	300 g/m^2	396

Biofence is classified as a 100% vegetable organic fertiliser.

Soil was collected from a field which was shown to be infested with cyst juvenile nematodes, root lesion nematodes, stem nematode, stubby root nematodes and stunt/spiral nematodes. There were six replicates of each treatment (60 pots in total) and each pot was sown with 20 onion seeds (Variety Vision).

HDCI 036 was the most effective of the standard treatments tested.

Biofence, particularly the meal formulation was most effective of the new products at reducing nematode levels (particularly of root lesion nematodes) in soil but this must be balanced against the fact that it can double the time for seedling emergence. Further work is required to determine how to make best use of this product.
There was also limited evidence that HDCI 037 and HDCI 038 may warrant further evaluation.

Financial Benefits

Results suggest that guideline thresholds for free-living nematodes are far too conservative. If this is the case then growers can be much more confident that most land will not require a nematicide treatment unless it is infested with stem or root knot nematodes. This could mean significant savings of approximately £200/ha

Action Points

- Growers should continue to sample land for free-living nematodes but specifically to assess the risk for stem nematode or root knot nematode. These nematodes are only rarely recovered but can have a significant impact on the crop if present. With the exception of stem nematode and root knot nematode the majority of other free-living species appear to have limited effect on onion growth.
- Growers can have increased confidence that unless numbers of most free-living species are exceptionally high they will not require nematicide treatment. This could have a significant impact on gross margins but further work is required to confirm this.
- Soil sampling advice can be fine-tuned as a result of monitoring nematode numbers and soil moisture and temperature over one year at three soil depths. Most reliable counts are likely to be achieved by sampling at 0-15 cm and avoiding the coldest months and waterlogged soil. For root lesion and stunt/spiral nematodes samples could be taken pre- or post-cultivation.
- Soil sampling for stem nematode should follow the guidelines above until further information is available on how this nematode is distributed through the soil profile and how it reacts to changes in soil temperature and moisture and whether it is affected by soil cultivation.

When sampling fields for stem nematodes (Project FV 327), individual soil samples (which can be bulked) should be taken from at least 100 uniformly distributed points per 4 ha

to give the best chance of detecting the pest and to ensure that an acceptable measure of the average numbers of nematodes present is obtained.