

Evaluating efficacy of application of entomopathogenic nematodes via a drip line irrigation system

A. P. Brown, J. P. Pearce, D. J. Wright



Outline

- A guide to the use of drip irrigation in UK agriculture.
- The possibility of integrating EPN application into already existing irrigation systems and the problems with this approach.
- Suggestions on how these may be able to be overcome.
- Future possibilities for application of EPN.

Drip irrigation in UK agriculture

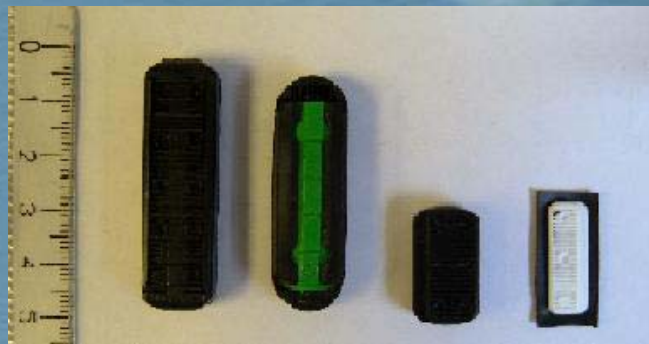


Drip irrigation in UK agriculture

- Drip irrigation used in many high value crops highly dependent on water.
- Within the UK the two main irrigation companies are Netafim (Israel) and T-Systems International (USA), with approx. 5 other smaller companies.
- Netafim has largest market share (7x nearest rival).
- There are a lot of choices for growers, EPN application suitability has never been considered. Guidelines are needed.

Variety of drip irrigation lines available

- Grower can choose from:
 - Supplier
 - Model of irrigation line (Netafim = 12)
 - Flow rate (3 or 4 rates)
 - Emitter spacing (up to 11 spacing)



- Variations in cost are one of main factors but this is changing.

Why apply via drip-line irrigation?

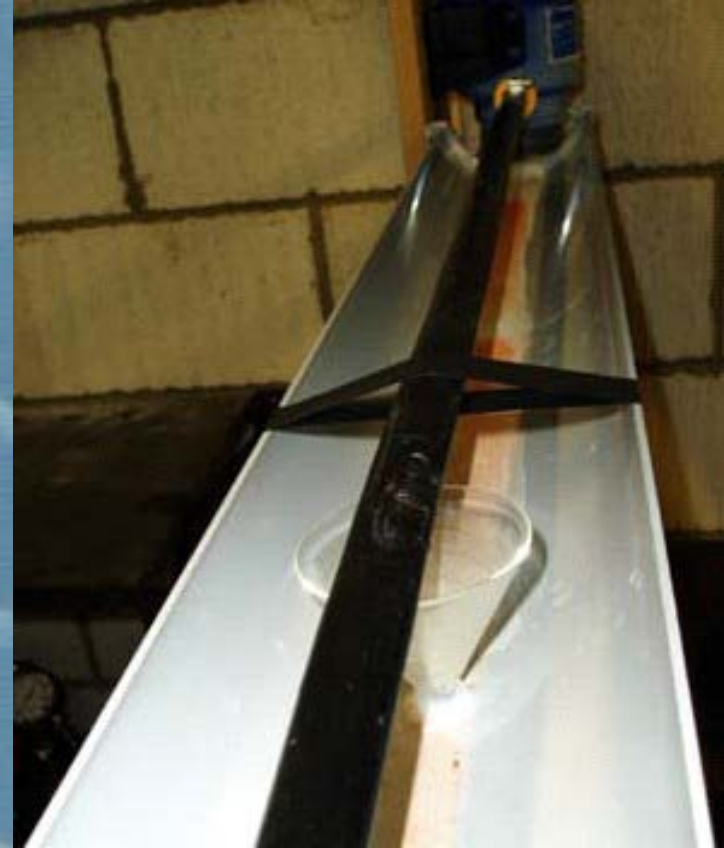
- Very few EPN specific application devices have been developed for this niche market.
- Many high-value crops, onto which nematodes are applied, have irrigation systems already in place.
- Integration into existing irrigation systems widens the market potential of these products.
- With >80% of invertebrate pests having at least part of their lifecycle in the soil, application via irrigation systems would enable EPN to be placed close to their target.

Methods

- A 100 m irrigation rig has been constructed to allow accurate sampling of water and EPN emission from set points along the irrigation tape.
- Irrigation line lengths of 100, 79, 50, 25 and 18 m were investigated.
- Irrigation tape used: Netafim RAM17012.

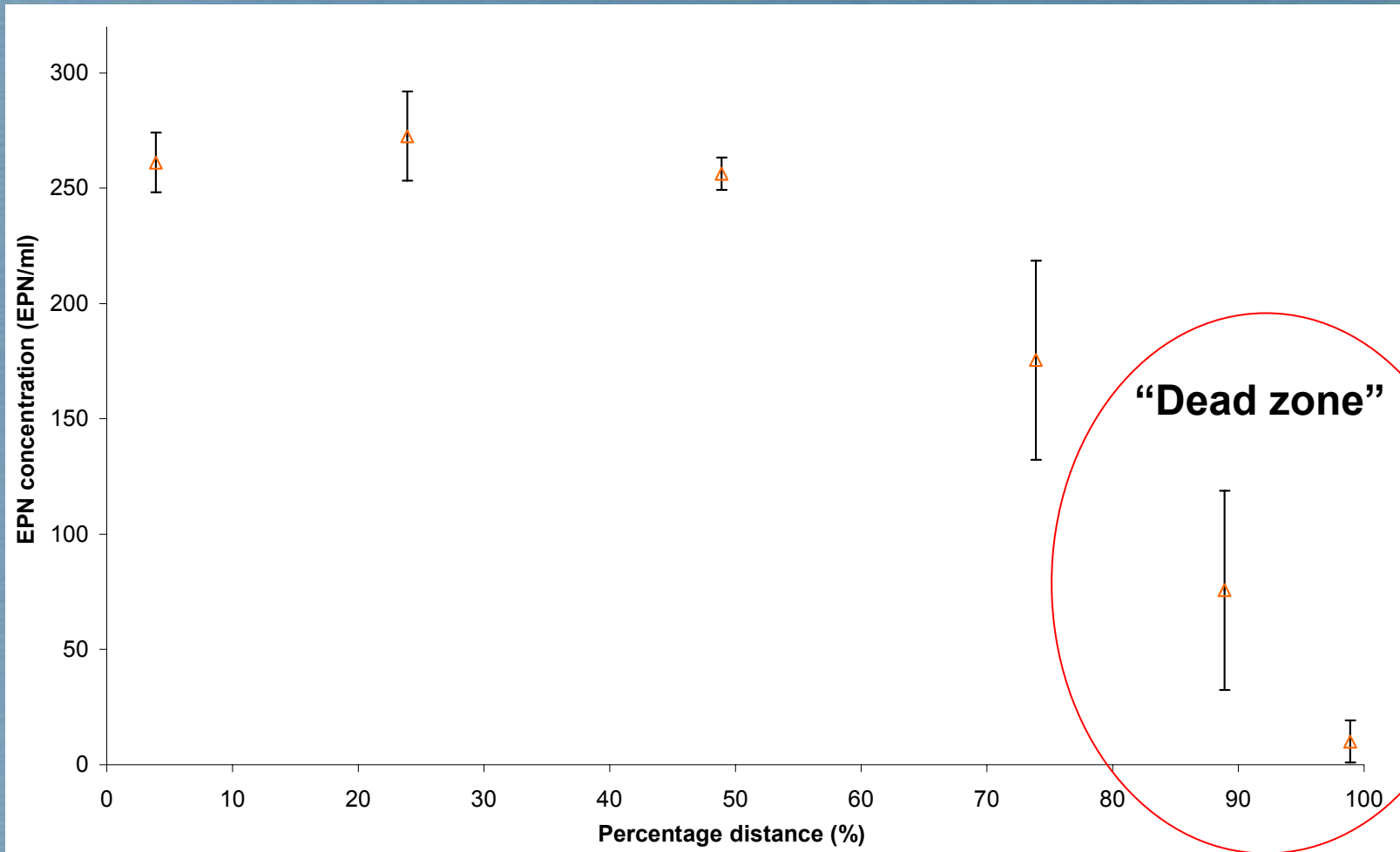


Methods: The irrigation system



Preliminary studies identified problem

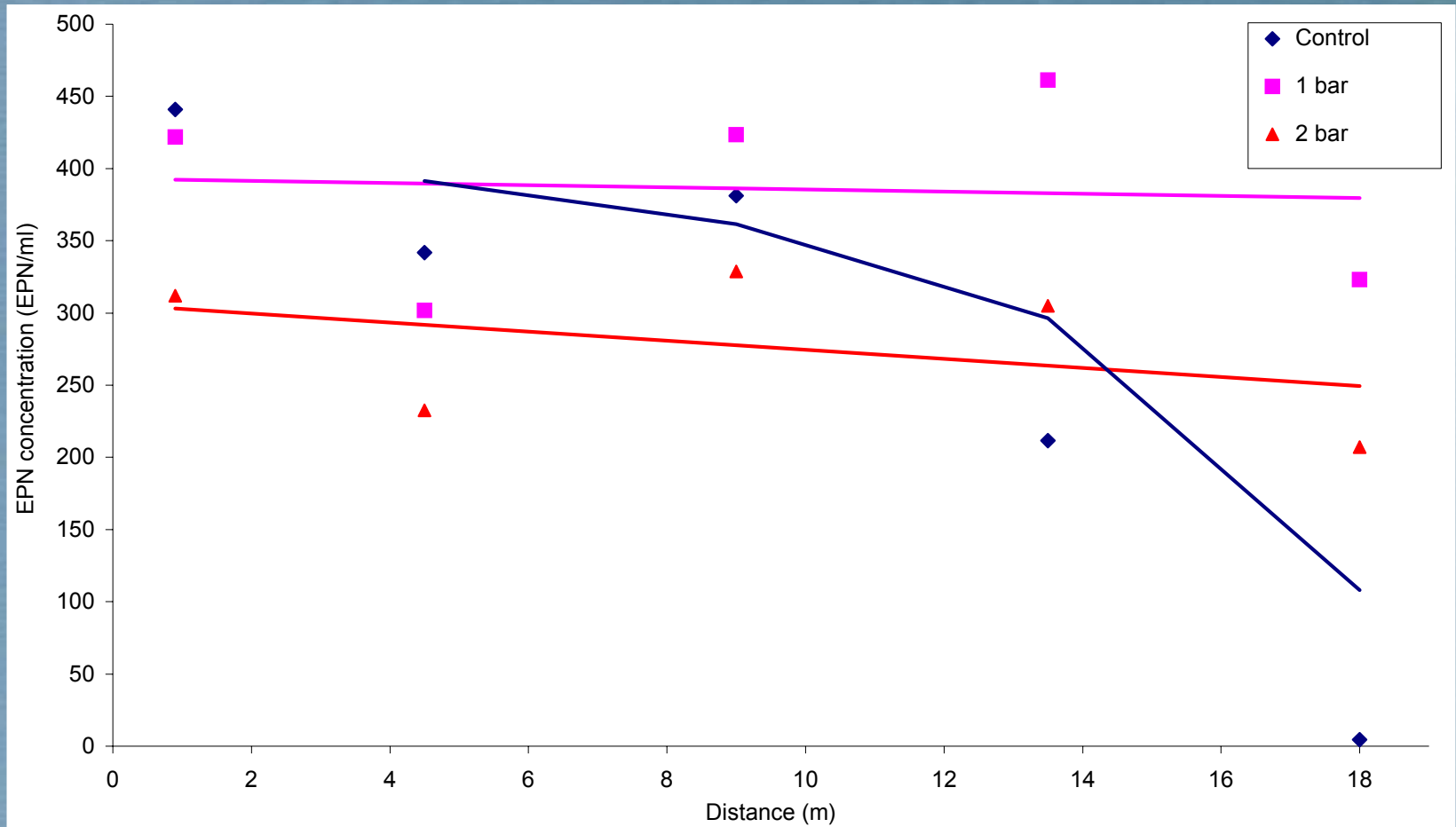
General trend in total EPN released along an irrigation tape.



Settling of EPN can occur in two places:

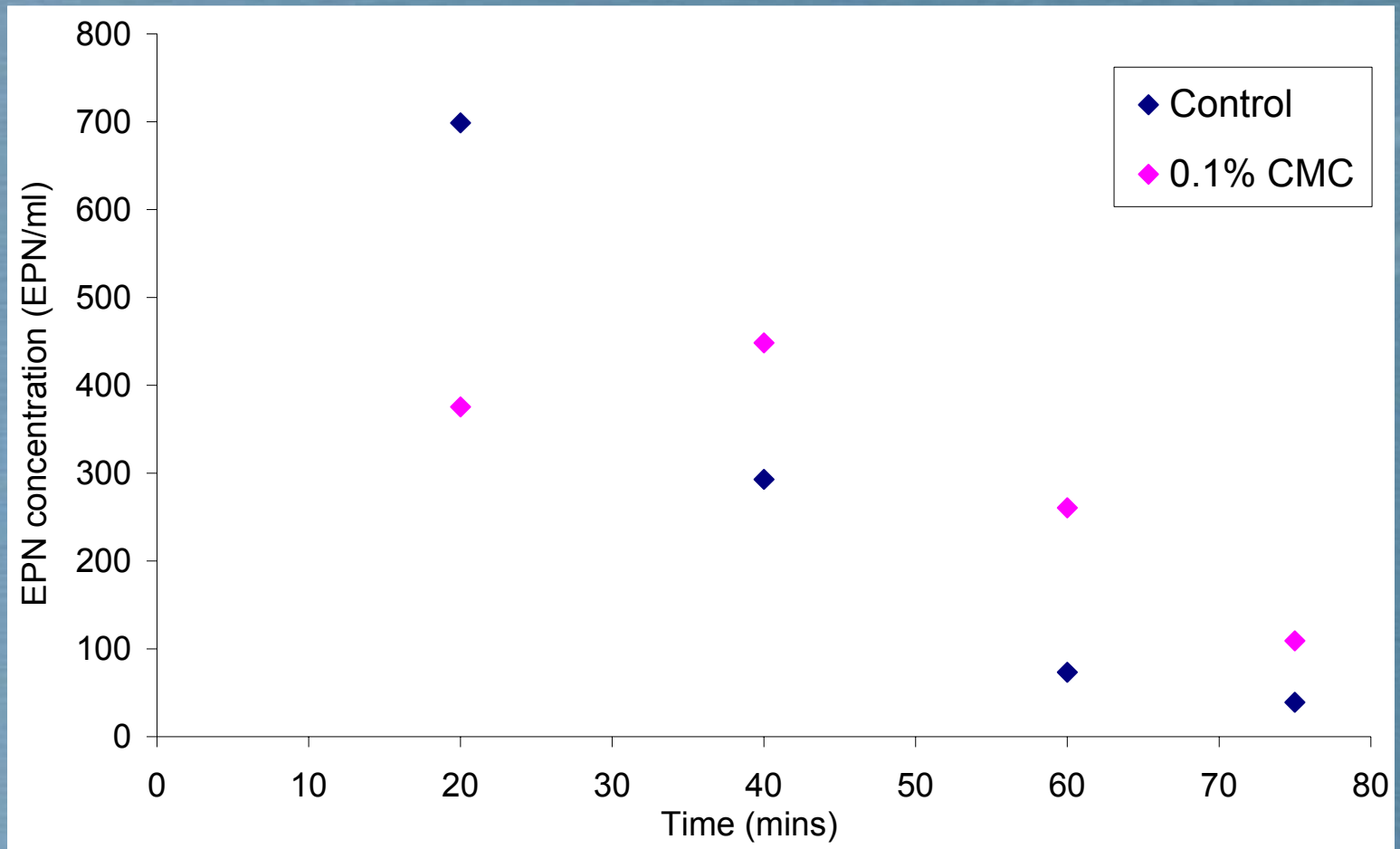
1. The irrigation tape (caused by stagnation of water)

Effect of irrigation tape internal flow rate on EPN distribution.



2. Within the tank mix prior to irrigation

The effect of adding carboxymethylcellulose (CMC) to tank mix.



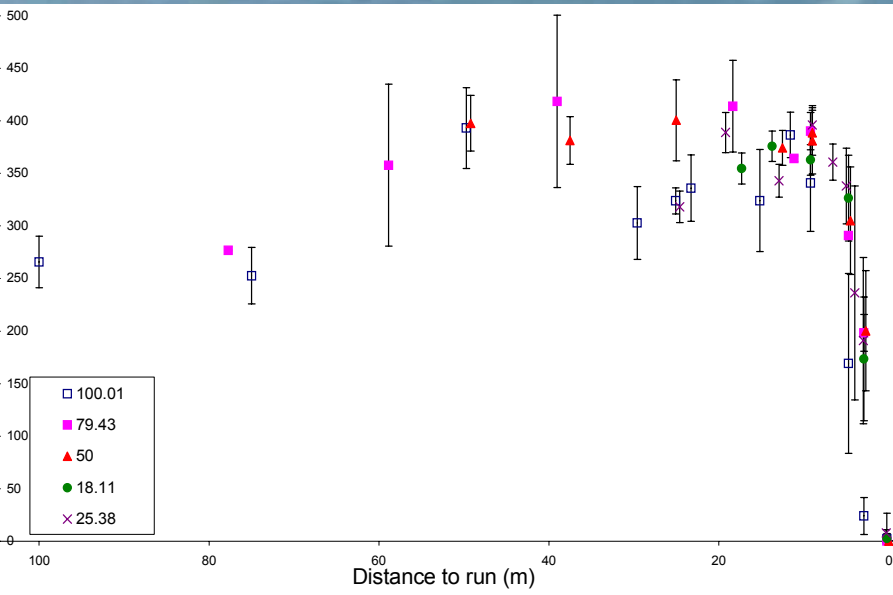
Modelling EPN output from an irrigation line

Aim: Investigate “Dead zone” region of irrigation line.

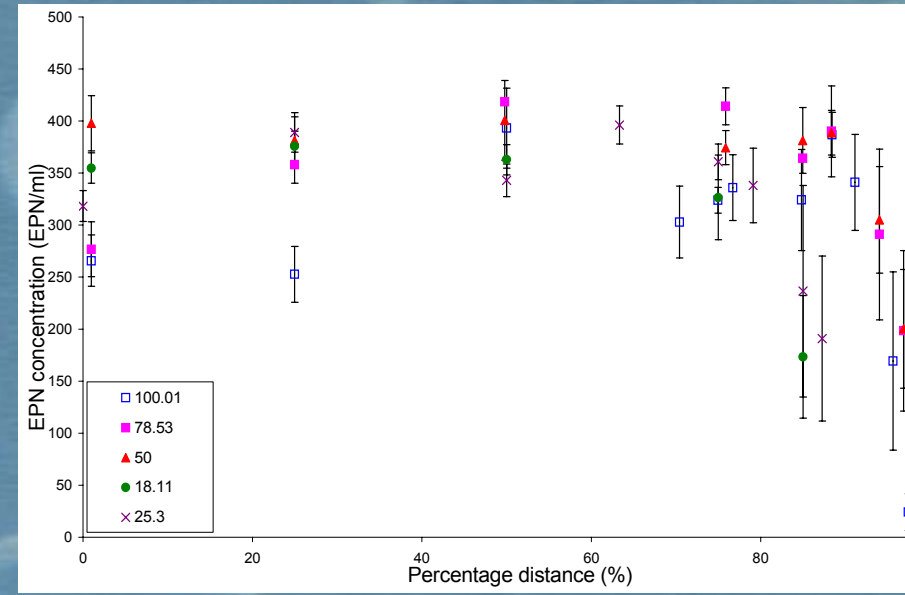
- 100 l water/EPN mix.
- Different length irrigation line used (100, 79, 50, 25 and 18m).
- Sampling points positioned at percentages of the line as well as set differences from the end.
- Reynolds number calculated at point where EPN output is reduced.

The effect of total irrigation line length on EPN release distribution.

1. Effect of distance to run on EPN output



2. Effect of percentage distance on EPN output



Results

Percentage to run model:

$$r^2 = 0.544 \quad (\text{df}, 102)$$

$$p = 4.74 \times 10^{-16}$$

HOWEVER.....

Set distance to run model:

$$r^2 = 0.545 \quad (\text{df}, 103)$$

$$p = 2.2 \times 10^{-16}$$

Percentage distance to run model against set distance to run model:

$$p = 0.7419$$

Conclude: Size of “Dead zone” increases with increased total length of irrigation line but it is not a proportional increase.

Reynolds number

- Unit less number to measure turbulence.
- <2000 laminar flow.
- >4000 turbulent flow.
- By modelling output and relating it to the Re future irrigation lines can have their suitability ascertained without experimental work.

$$Re = \frac{d u \rho}{\mu}$$

Re = Reynolds number

d = pipe diameter (m)

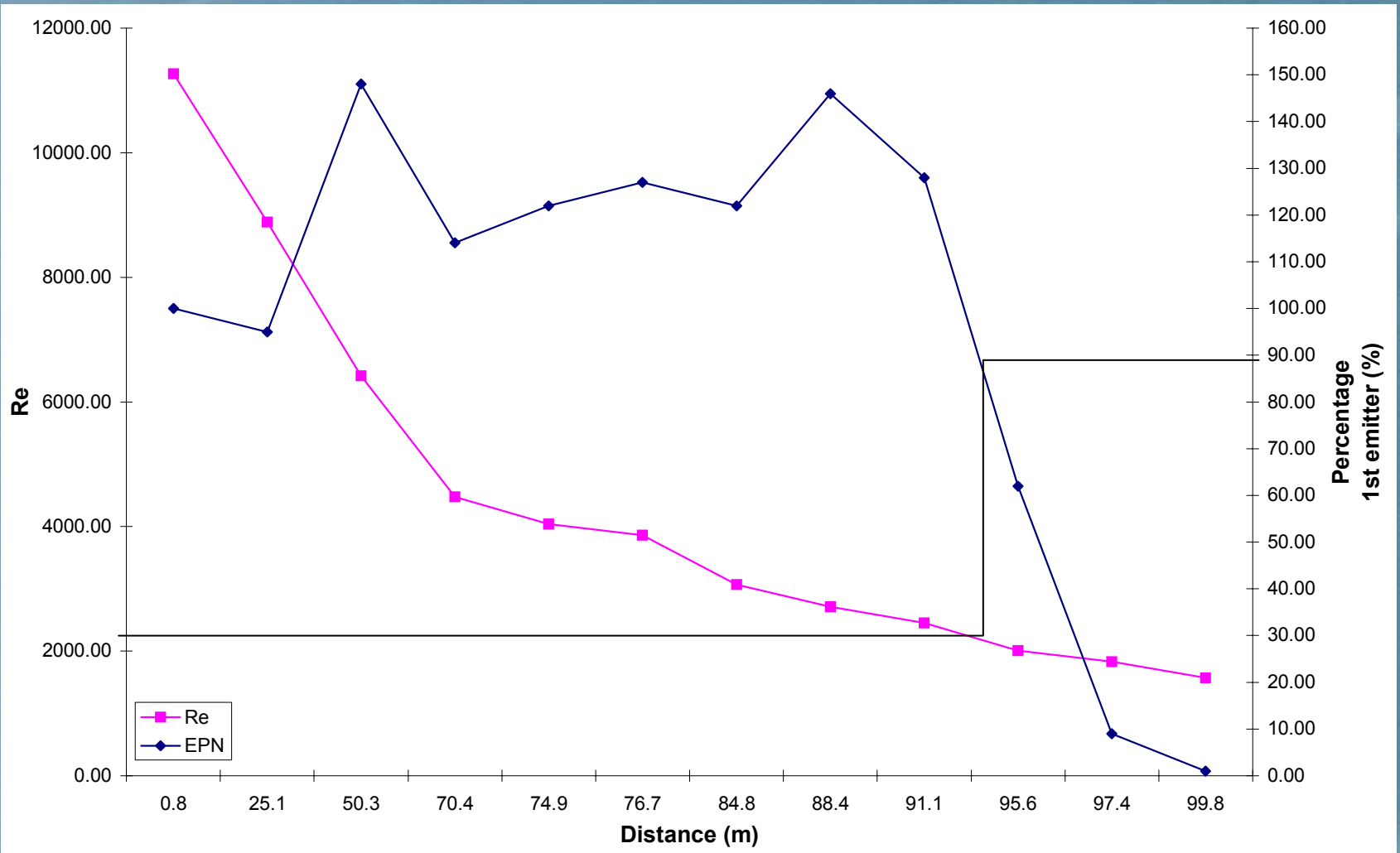
u = velocity (m/s)

ρ = density (kg/m³)

μ = viscosity (Nsm⁻²)

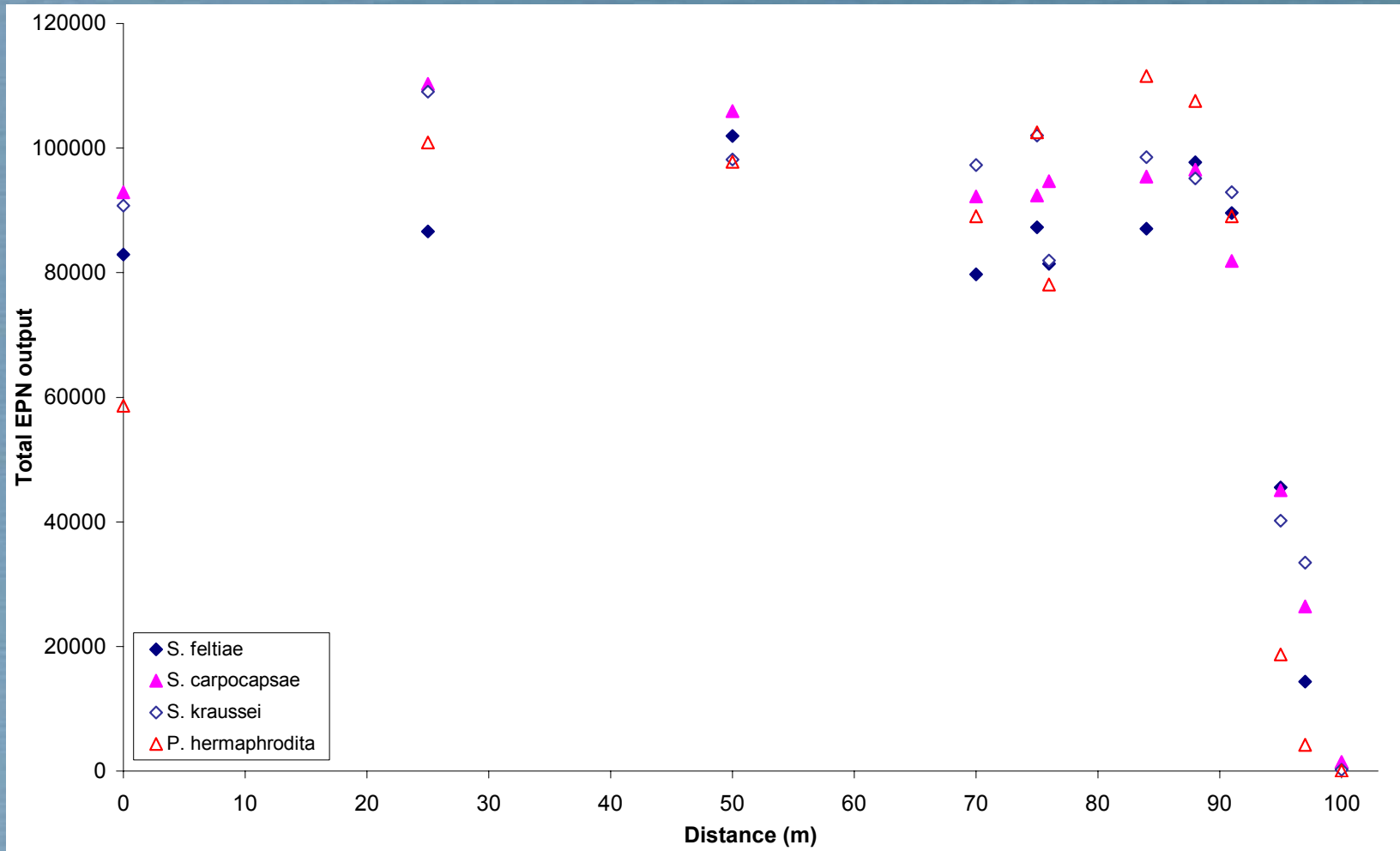
- Calculation takes into account flow rate and diameter.

Effect of distance on Reynolds number

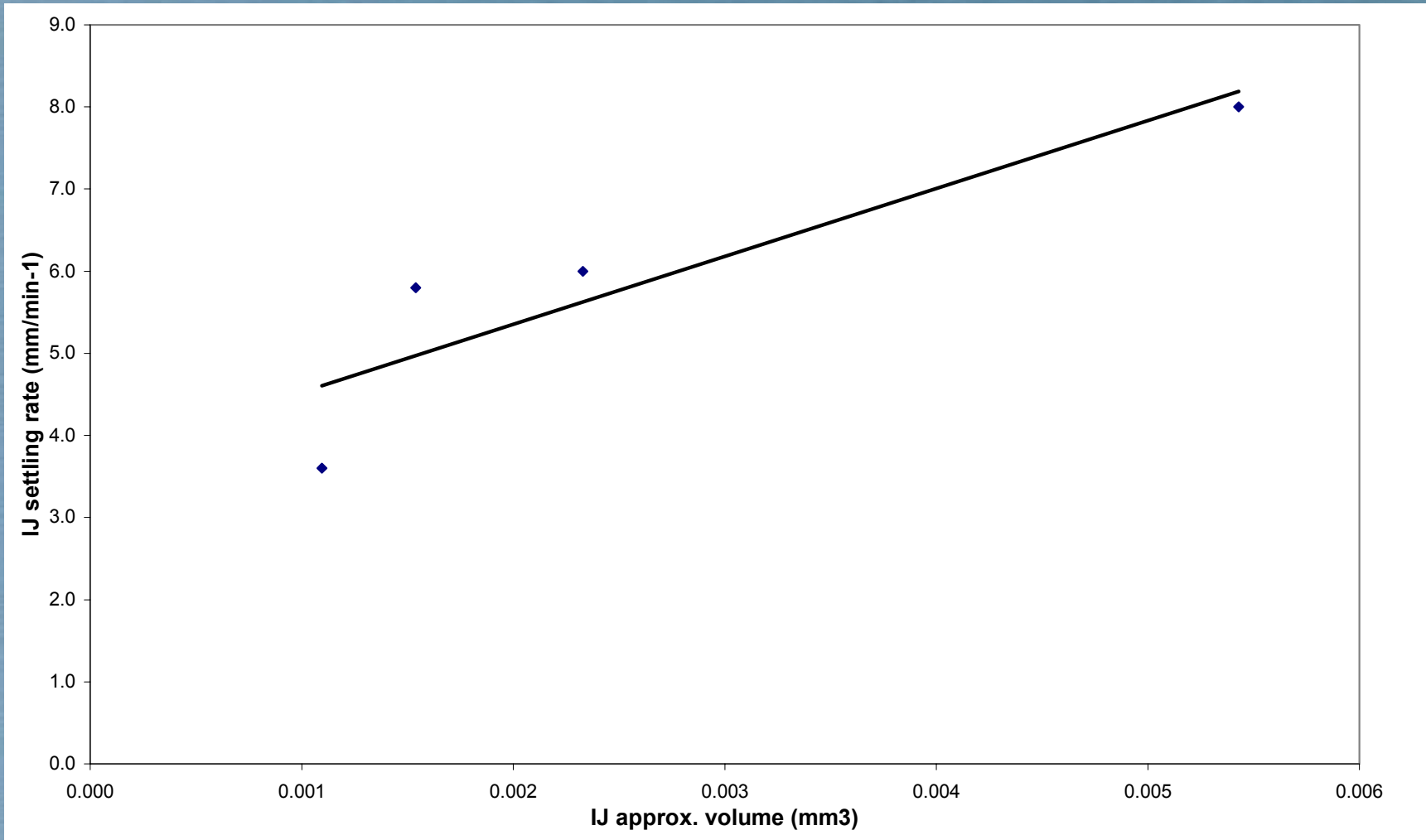


Effect of nematode species

The effect of nematode species on output distribution.



Effect of species size on settling rate

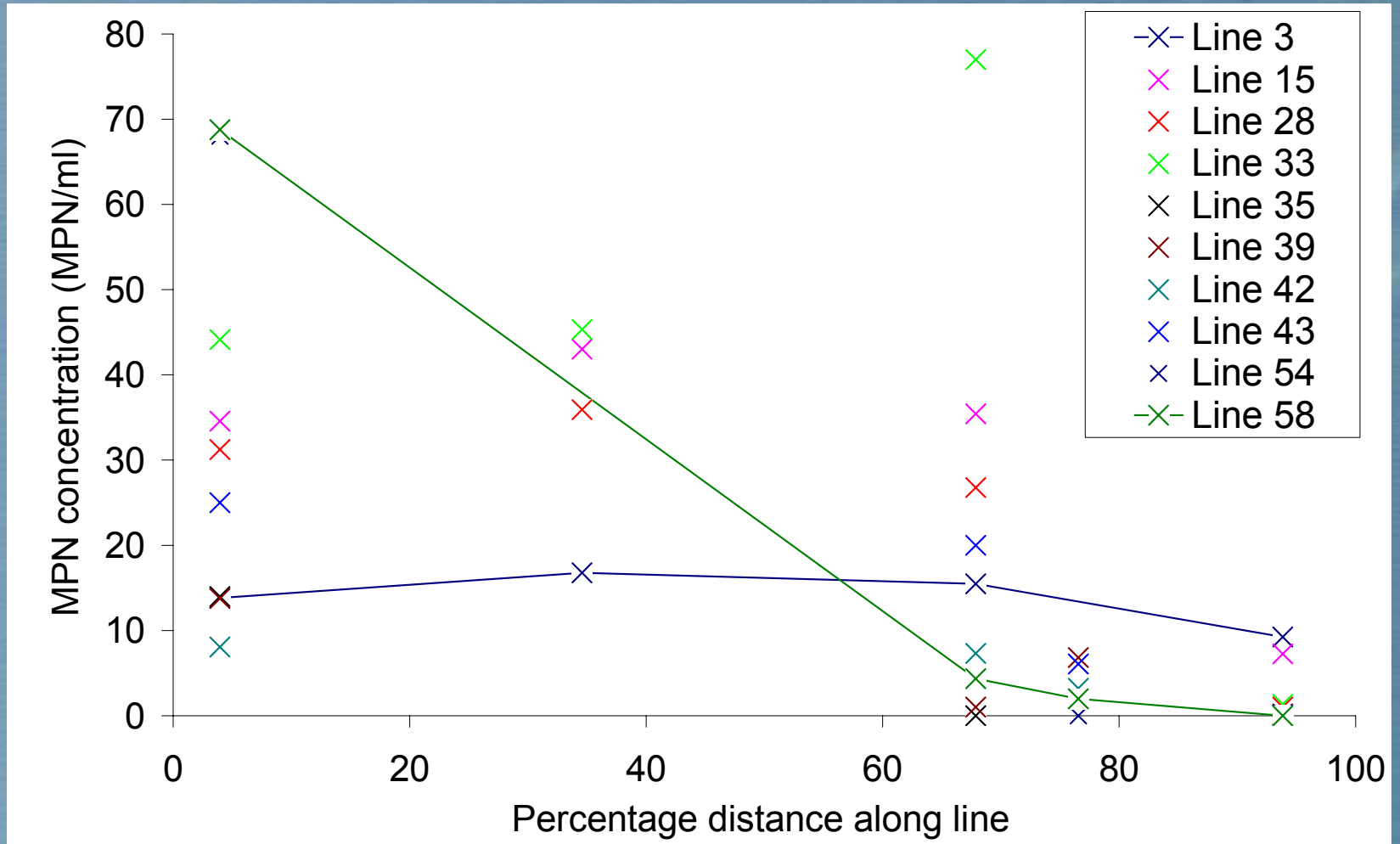


Field observations

- Field recordings of nematode output were taken along an 81 m irrigation line applying Nemaslug® to a lettuce plantation.
- Irrigation tape used – Netafim Streamline.
- Nemaslug® applied at a rate of 125 million/ha.
- Water applied at 0.5 bar at a rate of 10,000 l/ha.



Nematode distribution from field observations.



Conclusions

- With increased tape length the “Dead zone” at end of tape increases but not proportionally to the total length.
- There is an exponential decrease in EPN output with increased time.
- Nematode species does not affect output distribution for the tape types tested so far.
- For Netafim RAM 17012 EPN output is similar when being used within the irrigation manufactures pressure recommendations.
- The key factor affecting EPN distribution is most likely irrigation tape type (but more work is needed).

The future of work like this....

In-line drip irrigation



Overhead irrigation



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