Mapping Infestations of Potato Cyst Nematodes and the Potential for Spatially Varying Application of Nematicides

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Abstract. The most important constraint to potato production in the UK is the damage caused by the potato cyst nematodes (PCN) Globodera pallida and Globodera rostochiensis. These are serious pests, capable of causing substantial yield loss. Modern management systems depend heavily on nematicides which, at c. £60 ha\(^{-1}\) for granular and c. £550 ha\(^{-1}\) for fumigant nematicides, are costly to use. Mapping field infestations of PCN gives growers the option of applying nematicide variably across their fields. We intensively sampled a field, infested with *G. pallida*, before and after potatoes were grown and used the results to consider decisions the grower might have taken and to examine the consequences of various actions. Sampling intensity is important in generating accurate maps. In our results, spatial independence in PCN counts occurred at about 60 m, although there was also evidence of spatial independence at a range of 10–20 m in intensively sampled areas of the field. A strategic requirement to keep PCN population densities small, rather than the more tactical objective of avoiding yield loss, would mean blanket treatment of infested fields with granular nematicide. Maps could then be used to target ‘hot spots’ of PCN infestation for additional treatment with fumigant. This procedure would avoid blanket treatment with both types of nematicide, thereby diminishing the cost of chemicals applied and reducing possible environmental damage. However, the inverse relationship between pre-planting population density and multiplication rate of PCN makes it difficult to devise safe spatial application procedures, especially when the pre-planting population density is just less than the detection threshold.

Keywords: maps, nematicides, nematode control, potato cyst nematodes, spatial variation

Introduction

The potato cyst nematodes (PCN) *Globodera pallida* and *Globodera rostochiensis* are the most problematic pests faced by potato growers in Britain, being both persistent and capable of causing substantial loss of yield (Trudgill, 1986). A recent survey of potato production in England and Wales revealed that 64% of the fields surveyed were infested with PCN and that, of the infested fields, 67% contained essentially pure *G. pallida*.
(Minnis et al., 2000). Only 8% appeared to be pure G. rostochiensis, and the remaining 25% contained mixtures of the two species. Yield is lost at population densities as small as 5 eggs g⁻¹ soil (Trudgill, 1986), which means that nematicides are essential to control PCN if profitable yields are to be maintained. Barker et al. (1998) have shown how nematicides influence the yields and gross margins of potato crops grown on PCN-infested land, and that it is common for potato production in such circumstances to be more profitable if two different types of nematicide—a fumigant and a granular nematicide—are used in combination.

Operation over the last 30 years of systems for managing PCN that rely on rotation, resistance and granular nematicides has led to the current dominance of G. pallida. Fumigants such as 1,3-dichloropropene (1,3-D) appear to kill the two species of PCN non-selectively and have the additional benefit of releasing plant nutrients through the mineralisation of nitrogen. Granular nematicides are usually more effective than fumigants at killing PCN but act differentially on the two species—they are somewhat less effective against G. pallida than against G. rostochiensis. This means that each use of granular nematicide selects for G. pallida, a fact that is all the more serious because other components of programmes for managing PCN also act selectively in favour of G. pallida. When non-host crops are grown, G. pallida populations decline more slowly than those of G. rostochiensis, and resistant cultivars are much less effective against G. pallida than they are against G. rostochiensis. In the 1960s, G. rostochiensis was the dominant species in Britain (Brown, 1970). The current predominance of G. pallida is what has led to the increasing likelihood that growers will use 1,3-D plus a granular nematicide to control PCN, a practice that is in conflict with mounting pressure from environmentalists to use less nematicide.

Potato growing is highly specialised and capital intensive, with certain of the cultivation equipment and all types of planting and harvesting machinery suitable only for the potato crop itself. It is probably the single most profitable arable crop grown in Britain, and simple economics dictate that farmers who are able to produce good potato crops grow them in as short a rotation as can be sustained. This inevitably means the tactical use of nematicides to minimise yield losses due to PCN. Such an approach, which overlooks the more strategic aim of keeping PCN population densities as small as possible, frequently means that growers find that their PCN populations are increasing (Parker, 1998) as G. pallida comes to dominate.

Concern to protect the environment and recent narrow gross margins for potato production have stimulated the investigation of variable rate application for nematicides. Such approaches would reduce use of nematicide in Integrated Crop Management (ICM) schemes which growers have to adopt for assured produce schemes (Haydock and Evans, 1998). Of the current inputs on whole fields for potato production, variable application of pre-emergence herbicides or prophylactic blight fungicides would be inappropriate. Of the rest, nematicides are the most expensive inputs to potato production, and therefore the ones that offer the greatest potential savings. Granular nematicides cost c. £360 ha⁻¹ and fumigants c. £550 ha⁻¹ (Table 1).

The Global Positioning System (GPS) has made it possible for modulated treatments with nematicides to be accurately targeted (Haydock and Evans, 1995), and commercial packages have followed (e.g. Anon., 1997). These packages are usually based on individual sampling of hectare blocks within a field, followed by application (or not) of