PCN Biological and Cultural Controls

Trap Cropping

A potato crop is utilized as a trap crop and grown for 5-7 weeks and then destroyed. The goal is to limit nematode reproduction by destroying the plants before females mature, but requires very careful timing. This method can be used at any time during the growing season. Trap cropping with potatoes has the potential to reduce *G. pallida* populations by 75%-85%. Research is underway in Northern Ireland investigating the use of wild, highly resistant but tolerant potato varieties in trap cropping schemes to be utilized for organic potato production.

The effectiveness of a potato trap crop is dependent on how many of the PCN eggs hatch within a specific window. Slow or late hatching nematodes may not be trapped sufficiently well to justify the costs. Trap cropping with potatoes requires careful plant management and expert advice. It is important that whatever method is used to kill the potatoes or to remove the plants is thorough and complete so that no host material remains for reproduction. Soil temperatures need to be monitored accurately and regularly. Trap cropping with potatoes has the inherent risk of increasing PCN populations rather than reducing them as the plant is a reproductive host.

Based on greenhouse experiments (Brodie, 1982) of *G. rostochiensis* and potato plants, 6 weeks after plant emergence *G. rostochiensis* densities declined 92% when plants were physically destroyed and 66% when plants were killed 4 wk after emergence. Observations of stained roots indicated that most of the *G. rostochiensis* juveniles that enter potato roots do so within 3 wk after plant emergence.

Additional experiments (LaMondia & Brodie, 1986) with resistant and susceptible potato cultivars to *G. rostochiensis*, found that the duration of plant growth was positively correlated with a decline in viable eggs when plants were killed with glyphosate but not when they were hand pulled. Whitehead (1977) also found that trap cropping for 6 wk reduced *G. rostochiensis* numbers in soil by 65%, compared to 20% decline under bare fallow. Whitehead concluded that timing is critical with potato trap cropping as destroying plants too early (4 wk) did not hatch juveniles whereas destroying a susceptible trap crop too late (8 wk) resulted in nematode reproduction and population increase.

Differences between the Whitehead (1977) and Brodie (1982) are inherent between greenhouse and field studies, with lower reduction occurring in the field than in the greenhouse. However, the 6 week time optima in both experiments is encouraging.

Research in greenhouses and small plots and field trials have been conducted in the Netherlands and in the UK using *Solanum sisymbriifolium* (sticky nightshade) as a trap crop to induce hatching of *Globodera* spp. eggs. *S. sisymbriifolium* is fully resistant to PCN, it stimulates hatch but does not allow *G. rostochiensis* or *G. pallida* to complete its lifecycle, there is no risk of population increase regardless of how long the crop grows, it

is easy to destroy, and it can optimally lower PCN populations by 50% to 75%. *S. sisymbriifolium* is not frost hardy and dies back in the fall.

Solanum sisymbriifolium can be plowed into the soil ahead of a potato crop the following spring, providing 10-12t/ha of green manure. Plant breeders in Holland have selected varieties which are commercially available in the UK from Branston Ltd and Greenvale AP Ltd, as DeCyst. Small scale trials in E England consisting of 16ha were planted in 2006, with the Dutch scheduled to plant 1000 acres also this year. This trapping method does not totally eliminate *G. pallida*, and would not be sufficient as a quarantine treatment. This trapping method would be appropriate for a suppression of PCN populations in infested fields.

Biological control

Fungi—Currently the parasitic fungi *Paecilomyces lilacinus* and *Pochonia* (syn. *Verticillium*) *chlamydosporium are primarily being utilized as biological control measures in England and the United Kingdom*. These fungi may be an appropriate control measure for potato production in the UK, where large numbers of PCN support reproduction of the parasites, but it is currently not acceptable for seed crops, which require total freedom from PCN.

Jatala et al. (1979) discovered *P. lilacinus* infecting eggs of *M. incognita* and *G. pallida* and females of *M. incognita*, the fungus has been isolated from eggs, egg masses, females, and cysts of many plant-parasitic nematodes throughout the world. *Pochonia chlamydosporia*, *Paecilomyces lilacinus*, and *Plectosphaerella cucumeria* are the most abundant fungi attacking females and eggs of PCN. *Pochonia chlamydosporia* is a generalist, a naturally occurring parasite of cyst nematodes, and facultative parasite of eggs from several genera of nematodes.

Isolates of *Acremonium sp*., *P. lilacinus*, *P. chlamydosporium* and *P. cucumerina* vary in their ability to reduce populations of PCN. Applications of selected isolates of these fungi have been shown to significantly reduce the multiplication of PCN on potatoes in both pot and small-scale field experiments. These were applied in the form of alginate pellets. Large inoculum levels and improved formulations are required. *Plectosphaerella cucumerina* has been shown to reduce *G. pallida* and *G. rostochiensis* multiplication by up to 60% in field trials. *Paecilomyces lilacinus* is marketed commercially (MeloCon WG also sold as BioAct WG-approved in US).

Rothamsted International (IACR) (Prof. Brian Kerry) in collaboration with CENSA (Dr. Leopoldo Hidalgo) in Havana, Cuba have developed a biological control product based on *P. chlamydosporia* to be launched commercially in 2006 in Cuba as KlamiC (meets US EPA standards) against root-knot nematodes.

P. chlamydosporia also has been shown to affect a decline of cereal cyst nematode populations in intensive cereal production in N. Europe. Different isolates have exhibited

host preferences (cyst). A single application remains effective for at least two successive crops infecting 60 % of nematode eggs.

Antagonistic rhizobacteria – isolates of *Agrobacterium radiobacter*, *Bacillus subtilis*, and *Pseudomonas spp*. have demonstrated potential as biological control agents for nematodes. *A. radiobacter* strain G12 was able to induce systemic resistance of potato against the potato cyst nematode *G. pallida*. The bacterium inhibited penetration and establishment of juveniles in potato root system and also reduced the hatch of *G. pallida* in vitro. It did not affect the juveniles that formed a syncytium inside roots and the sex ratio or number of eggs/cyst.

Isolates of *Pasteuria penetrans* are able to attack PCN. It is generally applied to the soil before a potato crop or it can be applied to non-potato crops in the rotation to increase PCN decline rates. *P. penetrans* is marketed commercially as a biological control agent, (Nematech Ltd., Tokyo) for root knot nematodes. Mass production is difficult.

None of the biological controls have provided greater than 80% control. Biological control would work well as part of an IPM program for control of PCN in combination with partial soil sterilization, solarization, nematicides, trap cropping, and partially resistant crops.

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