BIOECOLOGY AND BASIC IPM FOR POTATO NEMATODES

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Nematode surveys conducted in Idaho revealed that eighty five species of plant parasitic nematodes belonging to 32 genera have been recorded on 31 host plants from 21 counties. Of these, 37 species and 15 genera are new records in this region. Three groups of nematodes are important in potato production in Idaho. These groups include root-knot nematodes (*Meloidogyne* spp), stubby-root nematodes (*Trichodorus* and *Paratrichodorus* spp.) and root-lesion nematodes (*Pratylenchus* spp.).

NEMATODE BIOECOLOGY - A TOOL FOR IPM

Root-knot nematodes (*Meloidogyne* spp.) have been recognized as a major nematode pest on potato and are found in abundance especially in sandy soils. Although there are several species of root knot nematodes, the two most common on potato in Idaho and eastern Oregon are the Columbia root knot nematode (*M. chitwoodi*) and Northern root knot nematode (*M. hapla*). *M.chitwoodi* was first described on potato in Quincy, Washington and later in Iron County, Utah. Both species can attack potato and cause enlargement or bumps in the outer layers of the tubers, rendering them useless for either fresh packing or processing. These species also have a wide host range leading to population increases when other susceptible crops are grown in rotation with potato. Damage is usually most severe following alfalfa hay crops and during years with high spring temperatures. Root knot field damage is localized, usually in circles of various sizes, or is spread throughout an entire field with plants becoming chlorotic and stunted. Damaged roots are not able to obtain soil nutrients and symptoms appear as nitrogen or micronutrient deficiencies. Plants may wilt easily, especially in warm weather, due to root damage even though soil moisture may be adequate. The host range of root knot nematodes is wide, including alfalfa (*M. hapla*), wheat (*M. chitwoodi*), and other crops that are commonly grown in rotation with potato in Idaho and eastern Oregon and Washington.

Stubby root nematodes (*Trichodorus* spp. and *Paratrichodorus* spp.) are migratory ectoparasites and are found in sandy, moist, cool soils. Damage is profoundly influenced by soil moisture and is greater in wet seasons. These nematodes are important parasites of potatoes, not so much for the direct damage they cause but for the tobacco rattle virus they transmit to potatoes. This virus causes a disease of potato tubers called corky ring spot. Rusty brown, irregularly shaped lesions that have a corky texture appear in the flesh of the tubers. Nematode problems occur mostly in isolated sandy soil areas of southern Idaho. These nematodes have wide host ranges, making management with crop rotation difficult and relatively ineffective. Stubby root nematode is very mobile in the soil and may traverse large vertical distances; therefore, enumeration and determination of a

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threshold level is difficult. Two genera of stubby-root nematodes (*Trichodorus* and *Paratrichodorus* spp) nematode are economically damaging to potatoes.

The root lesion nematode *Pratylenchus,* a migratory endoparasite on potato, is of concern to potato growers because it can reduce yield indirectly by weakening and increasing stress on the plants and by making the plants more susceptible to fungal and bacterial diseases. There is also a positive correlation of root lesion nematodes with the incidence of verticillium wilt (early dying). Though more than 15 species of root-lesion nematodes are reported to parasitise potato, *Pratylenchus neglectus* is the predominate lesion nematode species in the state of Idaho. Two species of root-lesion nematode, *Pratylenchus neglectus* and *Pratylenchus penetrans,* can increase susceptibility of potato plants to the potato early dying complex. *P.penetrans* interacts strongly with the fungal pathogen *Verticillium dahliae*, the main cause of potato early dying. *P. neglectus* is not known to interact directly with Verticillium; however, high populations may be associated with other factors that reduce optimal growth, contribute to crop stress, and increase the incidence and severity of potato early dying. Larvae infect roots immediately behind the growing tips, causing reddish brown lesions around the root cortex. Lesions coalesce, turn black, and are often invaded by soil microorganisms, which can cause weakened root systems, reduced water and nutrient uptake, loss of plant vigor, and ultimately yield reduction. High populations of lesion nematodes cause areas of poor growth where plants are less vigorous, turn yellow and show stunted growth. Damage is often caused by direct feeding and usually only cortical tissues are affected. Extensive lesion formation and cortex destruction of unsuberised feeder roots has also been reported. Infected portions of the potato roots turn dark brown to reddish in color, and are susceptible to invading secondary pathogens.

INM STRATEGY IN POTATO CULTIVATION

Integrated Nematode Management (INM) is a sustainable approach to managing nematodes by combining biological, physical, and chemical tools in a way that minimizes economic, health, and environmental risks. It is an interdisciplinary system approach to combat plant parasitic nematodes on potato. Ideally, INM implies a bio-intensive approach to nematode management in which chemical nematicicides are rarely, if ever, used. The intentions of INM are to balance economic goals of farmers with larger goals of society, and to maximize farmer profitability while minimizing negative effects of nematode control on human health and the environment. INM on potato has come into practice in many parts of the country due to the recognition by growers of human health and safety risks associated with chemical nematicide use, environmental hazards, decreased availability of labeled nematicides, and the need for economically viable management strategies.

IMPORTANCE OF INM

In the current agriculture scenario INM have been emphasized due to the social, economical and environmental status in the agriculture society. Economic and social welfare of the INM depends upon a healthy environment and agricultural economy.

INM programs developed so far have already contributed to a decline in chemical inputs on many crops. This has the dual effect of increased profitability and environmental protection. Increased public concern about nematicide and pollution of streams and groundwater, effects on farm worker health, impacts on non-target species and general food safety has generated interest in programs with the potential to reduce these factors while maintaining farm productivity and profitability.

The importance of healthy environment and agriculture cannot be separated from its societal benefits. A healthy environment sustains agricultural production and the livestock and humans living there. Environmental impacts of agriculture should not negatively affect the supporting and surrounding ecosystems such as the basic soil resource, surface and groundwater resources, air quality, and wetland and aquatic habitats. The health of the rural economy and family farms depend upon the ecological sustainability of agriculture as a viable enterprise. Simultaneously and more immediately, maintaining an agricultural economy depends upon increased profitability of agriculture.

The INM approach emphasizes knowledge of nematodes and their life cycles, use of resistant varieties, timing of planting, cultivation, biological controls, and monitoring of the nematode population. If damage is deemed economically above threshold, judicious use of nematicides is considered. By knowing the biology of a nematode, and watching changes in nematode populations in the field, a farmer can implement non-chemical controls as the first line of defense. Nematicides and other chemical control measures can be more carefully applied when they are needed to prevent economic loss. Using fewer chemicals and choosing those with less ecological impact saves money and environmental resources.

INM - A PART OF IPM IN POTATO CULTIVATION

INM approach in the potato cultivation can be achieved by the inclusion of following components.

1. Screening of nematode resistant cultivars and include them as a rotational crop preceding to potato planting.

2. Exploitation of biotic diversity of predominant nematodes in the potato ecosystem to develop an effective nematode strategy.

3. Incorporation of green manure crops in the potato cropping system to maintain sustainability in potato production.

4. Development of chemical strategies as and when needed in the root knot nematode, stubby nematode and lesion nematode infested endemic regions.

I. SCREENING OF NEMATODE RESISTANT CULTIVARS

Two experiments were conducted under green house conditions to screen the tolerance level of 30 cultivars of bean against the Columbia root-knot nematode (*Meloidogyne chitwoodi*) and Northern root-knot nematode (*Meloidogyne hapla*) and include them as a rotational crop in the potato cropping system. Studies indicated that tolerance among the bean cultivars vary depend on the progeny and the characteristics of the specific cultivars. Nematode reproduction is an accepted parameter of root-knot nematode resistance and a terminology for the classification of host reaction. In two cultivars 'Apore' and 'Carioca' total nematode population (*M.chitwoodi*) in the root and the population per g of the root was minimum. Lowest level of total *M.hapla* population and per g of root was observed in the cultivar Kodiak.

II. ROOT LESION NEMATODE DISTRIBUTION

In order to find out diversity of lesion nematodes in the potato ecosystem, a nematode distribution study was conducted in potato fields from southwest, south central and southeast Idaho. It indicated that lesion nematodes are one of the predominant economically important nematodes found in all the potato growing regions of Idaho. *Pratylenchus* spp. has been recorded in potato fields from all the counties. Among all species, *P.neglectus* is the predominant one found in all the counties. Morphometric studies indicated that no significant differences were observed in the morphology of the specimens collected from different fields in Idaho. DNA analysis of the individual specimens from each species was carried out to confirm the variability that exists within and between species. It was found that sample collected from the Lincoln County showed the *P.neglectus*, which is different from the isolates reported in Idaho. DNA analysis further revealed that this isolate is similar to the isolate collected from a potato field in Canada.

III. GREEN MANURE STUDIES

Efficacy of cultivars of oil radish and rapeseed were tested for their potential to reduce the root knot nematode population and improvement of potato parameters under field conditions. Two cultivars of oil radish (Commodore and Picobello) and the rapeseed (Humus) were planted in a root knot nematode infested field during the fall in Parma, Idaho. Before planting of green manure crops the nematode population among the treatments were similar and differences observed were not statistically significant. The nematode population was reduced as a result of planting oil radish and rapeseed cultivars. Nematode population reduction was more pronounced due to planting of oil radish cultivar Commodore and Picobello than the rapeseed Humus. Biomass accumulation data proved that oil radish commodore produced the highest biomass (24.5%) as compared to rapeseed while Picobello produced a 16.7% increase over the rapeseed. Fresh root biomass production was also more in the oil radish cultivars than the rapeseed. However the potato yield differences observed due to the green manure incorporation was not clear. Hence the experiment will be repeated in the next year.

IV. CHEMICAL STRATEGIES

A. ROOT KNOT NEMATODE MANAGEMENT

Field experiments were conducted at two locations to study the efficacy of fosthiozate formulations along with Vapam in comparison with Telone on the control of Columbia root knot nematode in a potato field. Yield of potato tubers under different treatments in both locations indicated that there is a significant increase in Market yield followed by a significant reduction in nematode-infected tubers due to fosthiozate application as compared to control plot. Among all treatments, fosthiozate with vapam increased the marketable yield and total yield with the lowest nematode infestation. Percent of nematode infestation ranges from 0-17.4 and 0-1.9 for M-10 and Beaver field respectively.

Another experiment was conducted to determine whether Temik alone or combined along with Mocap is effective in reducing the nematode population and increasing tuber yield. Data indicated that application of Mocap along with Temik significantly increased the total yield of tubers as compared to untreated check. Percent of infection was reduced to 4.6 % as a result of this treatment. However, no significant difference could be observed between the untreated control and treated plots in terms of, marketable yield and nematode infested tuber yield.

B. STUBBY ROOT NEMATODE MANAGEMENT

An experiment was conducted for the stubby root nematode management in a commercial 'Russet Burbank' potato field at Rexberg, Idaho. Data indicated that no significant difference in total or marketable yields among any of the treatments was observed. However, percent infection of corky ringspot incidence ranged from 1.3 to 2.3%. Temik application significantly reduced the nematode infested tubers as compared to control or Thimet application.

In another experiment efficacy of Mocap alone or combined with Temik on root knot nematode was evaluated in a field planted with the potato cultivar 'Russet Burbank'. There was a significant increases in the Market yield and total yield by the application of Mocap alone or combined with Temik as compared to the control. Yield increase was more by Mocap + Temik treatment than Mocap alone. Percent of nematode infested tubers was reduced to 60.3 and 25.8 by Mocap and Mocap + Temik as compared to the control (95%).

C. STUBBY ROOT AND LESION NEMATODE MANAGEMENT

In a field experiment conducted in a commercial 'Russet Burbank' potato field at Rexberg, Idaho it was found that there is no significant difference in the market yield and total yield due to the Vydate application. However there is a trend towards an increase in the market yield and total yield due to Vydate treatments. No difference could be observed in stubby root nematode infected tubers due to the treatments.