IMPACT OF NEMATODE MANAGEMENT OPTIONS ON POTATO CULTIVATION

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Potato nematodes continue to be important pests of the Idaho potato crop. Their management must take into account species or races of nematodes, the availability of non chemical methods, the cropping system and the cropping history, economics, and the climate. Historically, nematode management has focused on the exclusion and adoption of nonchemical management tactics since few nematicides were available prior to 1943. Although few nematode management practices are available, due to lack of hard data and variables such as nematicide dosage, costs of chemicals, efficacy of management tactics, and crop susceptibility, the outlook for integrated nematode management (INM) is positive. Following the basic strategies of INM such as prevention, cultural practices, resistant cultivars, nematode-resistant trap crops and chemical control, can lead to a successful integrated nematode management program.

In Idaho there are eighty five species of plant parasitic nematodes belonging to 32 genera on 31 host plants. Of these, 37 species and 15 genera are newly recorded in this region. Fortunately, only 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.).

Root-knot nematodes (*Meloidogyne* spp.) have been recognized as a major nematode pest on potatoes and found in abundance, especially in sandy soils. Although there are several species of root knot nematodes, the two most common on potatoes 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 potatoes in Quincy, Washington and later in Iron County, Utah. Both species can attack potatoes and cause enlargement or bumps in the outer layers of the tubers, rendering the tubers useless for either fresh packing or processing. These nematodes have a wide host range leading to population increases when other susceptible crops are grown in rotation with potatoes. Damage is usually most severe following alfalfa hay crops and during years with high spring temperatures. Root knot nematodes cause field damage that is localized, usually in circles of various sizes, or 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 potatoes in Idaho and eastern Oregon and Washington.

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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 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 potatoes, is of concern to potato growers because these nematodes 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 die). Two species of root-lesion nematode, *Pratylenchus neglectus* and *Pratylenchus penetrans,* can increase susceptibility of potato plants to the potato early die complex. *P. neglectus* is the predominate lesion nematode species in the state of Idaho. *P. penetrans* interacts strongly with the fungus pathogen *Verticillium dahliae*, the main cause of potato early die. *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 die. 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.

POTATO NEMATODE MANAGEMENT VERSUS CONTROL

The philosophy of INM is to *manage* or *tolerate* certain levels of the nematodes, that is, to reduce their damage to economically tolerable levels. This approach recognizes that crops are ecosystems and that the presence of the nematode does not necessarily mean existence of a problem. When INM is practiced, natural enemies of nematodes are enhanced and disturbed as little as possible so they can assist in reducing nematode populations, and chemical nematicides are used only when needed. The decision as to what management technique to use and when usually involves knowing whether or not the nematode is present, at what stage of growth, the environmental conditions, and the susceptibility and stage of the crop. Often, the cropping history plays an important role in knowing what kinds of nematode problems to expect.

FACTORS ENHANCING INM STRATEGY

Initially, progress in INM of potatoes was slow due to the abundance of inexpensive, effective, synthetic nematicides and limited knowledge of the long-term effects of nematicides on organisms and the environment. However, as use of these compounds increased and became widespread, several factors lead to serious negative impacts on farm profits and an increased interest in designing INM programs.

Two primary factors involved are 1) effect of nematicides on non-target organisms and 2) increased regulation. As new legislation was enacted, the federal government and agencies began playing more of an active role in promoting INM within research and extension programs. Major factors mentioned above have necessitated the urgency of developing INM programs for effective and affordable potato nematode management.

IMPORTANCE OF INM

The importance of a 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 the increased profitability of agriculture.

The INM approach emphasizes the 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 including them as a rotational crop proceeding to potato planting.

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

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

I. GREEN MANURE STUDIES

In a green house experiment, efficacy of three arugula varieties and two Middle East spice plants were compared for their effect on the multiplication of *M.chitwoodi*. These five plant types and tomatoes were planted on November 1 in a completely randomized block design with five replications each. The crop was harvested on July 2 and data on the fresh and dry weight of shoots and roots along with the nematode population in the soil and per g of root were recorded. Data indicated that among all varieties Lebanese (Rucola) reduced the nematode population (95.5%) followed by an Egyptian variety (69.1%)

In another green house study, effectiveness of three green manure varieties (caley pea, cahaba vetch, and oil radish) were compared to tomatoes for the multiplication of *M.chitwoodi*. All three varieties and tomatoes were planted on July 7 in a completely randomized block design with five replications each. Harvest data indicated that among all varieties, Caley Pea showed maximum fresh weight of shoot and root. The lowest level of total nematode population in the root and the maximum percent of reduction of root population (98.7) were also observed in Cahaba Vetch (99.3) and Caley Pea (98.5).

The efficacy of cultivars of oil radish and rapeseed were field tested for their feasibility in long term rotation practices. Cultivars of oil radish (Defender, Comet and Mustard blend) and rapeseed (Humus) were planted on August, 2004. Maximum biomass was recorded in the Comet (2.4 t/A) and mustard blend (2.5 t/A) planted plots as compared to other plots. In the spring 2005 potatoes were planted and yield data at harvest indicated that there was a significant increase in marketable tuber yield in the green manure crop plots as compared to fallow. Root knot nematode-infected tubers were reduced from 16.5 % in the fallow plots to 1.0 % in the green manure planted plots. Marketable and total yield was also increased by the use of green manure crops as compared to fallow treatment.

II. SCREENING OF ALFALFA GENOTYPES

An experiment was conducted under green house conditions to evaluate the tolerance level of fifteen alfalfa genotypes to the Columbia root knot nematode *M.chitwoodi*. In the cultivar Cg 2003-55 there was a significant increase in the fresh weight of shoot and root followed by the lowest level of *M.chitwoodi* root population and total population in the soil and root compared to the other alfalfa genotypes.

III. NEW NEMATICIDE STUDY

Studies were initiated to test the efficacy of a new product at different rates on the Columbia root knot nematode *M.chitwoodi* on potatoes. All rates of the product reduced the nematode population in the soil and infected tubers followed by an increase in the clean tuber yield. Percent of tuber infection was also reduced in the treated plots as compared to the control.

IV. ROTATION STUDY

A new root crop rotation experiment was initiated this year to examine the long-term effects (multiple years) of green manures and different cropping systems in a field with a previous rotation of sugar beets and wheat. The field was split into three equally sized experimental portions (A, B and C). Each experimental field has eight plots and each field will be used in a one to three rotation (potatoes once every three years). Three consistent crops planned for use in these experiments will be wheat and sugar beet, onion and the third early crop may be bean, sweet corn or early potato. Green manure will be planted in the fall or the field will be left fallow, depending on the rotation scheme. In the spring of 2005 plots B and C were planted with sugar beet and A was planted with potato. In the fall of 2006 A was planted with green manure and sugar beet, onion and potato will be planted respectively in the spring 2006. Nematode population levels will be studied in the different cropping systems.

V. EGG HATCHING STUDY

A study was conducted under controlled conditions to evaluate the effectiveness of five oil radish varieties on reducing egg hatch of Columbia root-knot nematode (*Meloidogyne chitwoodi*). Five treatments (Colonel, Defender, Luna, Terraprotect, and water), replicated five times, were evaluated to determine the effect of root extracts on *M. chitwoodi* egg hatch. Among all varieties, the maximum percent reduction of egg hatch was observed in Colonel when compared to the water untreated control.

VI. EFFECT OF STORAGE TEMPERATURE ON NEMATODE SEVERITY

The effect of storage conditions on the development of nematode symptoms was evaluated by storing harvested potatoes at 35, 45 and 50 degrees. After 12 weeks, the stored potatoes were evaluated for nematode severity. Data indicated that the percent infection was more at 45 degrees (19.4%) than at 35 or 50 degrees.