INTEGRATED NEMATODE MANAGEMENT OPTIONS FOR THE SUSTAINABLE POTATO PRODUCTION

Saad L. Hafez and P. Sundararaj

Integrated nematode management (INM) on potato requires flexibility and must take into account species or races of nematodes, the availability of resistant or non-host plants, the cropping system and the cropping history, economics, and the climate. Historically, nematode management has focused on exclusion and nonchemical management tactics since few nematicides were available. Although few economic thresholds are known or clearly understood for nematodes due to lack of hard data and variables such as potato market prices, costs of management, efficacy of management tactics, and crop susceptibility, the outlook for potato nematode management is positive. Following the basic strategies of INM such as prevention, cultural practices, resistant cultivars, nematode-resistant trap crops and chemical control will lead to the success of integrated potato nematode management at the field level.

POTATO NEMATODE MANAGEMENT VERSUS CONTROL

The philosophy of INM is to *manage* or *tolerate* certain levels of the nematode, that is, to reduce the 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 and at what stage, 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 potato 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.

Presented at the Idaho Potato Conference on January 23, 2002.

Two primary factors involved are effect of nematicides on non-target organisms and increased regulation. Broad-spectrum chemicals kill many types of organisms indiscriminately. This effect can be useful for controlling several nematodes at once. However, nematodes that were not a problem in the cropping system then suddenly become pests. This is because most nematode species are kept under control naturally by other parasitic or predaceous organisms such as fungus and bacteria. The use of these nematicides kills the beneficial organisms, resulting in outbreaks and the need for more chemical use. 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.

REALISTIC APPROACH OF INM

Information is a fundamental component for realistic approach of potato INM for two reasons. First, because an understanding of the potato ecosystem is essential to preventing nematode problems, and second, because INM relies on close monitoring of nematode populations in order to determine when a population has reached an economically damaging threshold. Economic thresholds for nematode are developed from research that takes three main factors into account:

- Physical damage caused by the presence of the nematode at a known level of infestation,
- Revenue losses resulting from that damage, and
- Costs of treatment.

INM - A PART OF IPM IN POTATO CULTIVATION

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

1. Screen for nematode resistant bean and alfalfa cultivars and include them as a rotational crop preceding to potato planting.
2. Diagnosis and document the diversity of predominant nematodes in the potato ecosystem to develop an effective nematode strategy.
3. Determine the economic threshold level of root-knot nematodes on potato crop.
4. Evaluate and incorporate the green manure crops in the cropping system to suppress the population of root-knot nematode in a potato production.

5. Develop chemical strategies as and when needed in the root knot nematode, infested endemic regions.

Screening of Bean Cultivars

An experiment was conducted under green house conditions to screen the tolerance level of 30 cultivars of bean against the Columbia root-knot nematode (*Meloidogyne chitwoodi*) and include them as a rotational crop in the potato cropping system. Experimental design was a completely randomized block design with 30 cultivars of seven replications each. Single seed of each cultivar was planted on May 16, 2001 in a cone filled with 1400 cc of sterilized soil. Two weeks after planting seedlings were inoculated with 3000-second stage juveniles of *M. chitwoodi* obtained from culture maintained on tomato plants. Normal cultural practices were carried out. Eight weeks after planting (June 26, 2001) plants were uprooted. Nematodes were extracted from roots of each cultivars and population was recorded. Dry weight of root from each cultivar was recorded and nematode population was represented as number of nematodes per g dry weight.

Tolerance among the bean cultivars varies depending 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 ‘A252,’ total nematode population in the root and the population per g of the root was minimal.

Screening of Alfalfa Genotypes

Two experiments were conducted under green house conditions to evaluate the tolerance level of five alfalfa cultivars to the lesion nematode (*P. penetrans*). Cones of 150 cc capacity were filled with sterilized soil on July 31, 2000 and seeds of each alfalfa cultivar were planted in each cone. On August 7, seedlings were thinned to three per cone and inoculated at the rate of 100 nematodes per container with *P. penetrans* that had been maintained on corn roots in tissue culture. One hundred days after planting, plants were uprooted and data on nematode population in the root and total population including root and shoot population were estimated. Fresh and dry weights of the shoot, as well as root, were also recorded. Data indicated a significant difference in the parameters as compared to the cultivar Lahontan. Fresh and dry weight of shoot, as well as root, were significantly higher, while the nematode population per gram of root was lower than the cultivar Lahontan.

A second experiment was conducted with 16 alfalfa cultivars and tested with *P. penetrans* under green house conditions. Data indicated that the variety ZX 9940A showed minimum nematode population per gram root and also the total nematode population in the root and soil. Maximum fresh root weight and shoot weight was observed in the variety ZC 9640A.

Root Lesion Nematode Survey

In continuation of the previous year, a root lesion nematode survey was conducted in potato fields from southwest, south central and southeast Idaho. One sample represents

3500 to 4000 acres within a production region and a total of 109 samples were collected during 2001. The number of samples collected within a county is based on the historical potato acres within that county. Locations selected within the county are representative of typical soil types and cropping and cultural practices of all growers within the county. One sample was a composite of about 20 cores to a depth of 14 inches taken randomly from within a 1 to 2 acre location within the field. Survey revealed 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 if variability exists within and between species. It was found that sample collected from Lincoln County showed a *P. neglectus* that 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.

Green Manure Studies

Efficacy of cultivars of oil radish and rapeseed was tested for their potential to reduce the root knot nematode population and improve potato parameters under field conditions. Two cultivars of oil radish (Commodore and Colonel) and one rapeseed cultivar (Humus) were planted on August 14, 2001, in a root-knot nematode infested field during fall in Parma, Idaho. Each variety was replicated six times in a completely randomized block design, and a fallow treatment was included as a control check for comparison. Eight weeks after planting, samples were collected for biomass evaluation and the fresh and dry weight of the crops were estimated. Nematode population in the soil was determined from soil samples collected before and after trap crops were grown. All the cultivars were mechanically chopped, and roots and forages were incorporated in the soil by double disking. Potato variety Russet Burbank will be planted in the following spring.

Before planting of green manure crops, the nematode populations among the treatments were similar and differences observed were not statistically significant. But 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 cultivars Commodore and Colonel than the rapeseed Humus. Biomass accumulation data proved that oil radish Commodore produced the highest biomass (19.2T/A) as compared to rapeseed while Colonel produced 18.8 T/A.

In another experiment rapeseed Humus and oil radish Commodore were planted in fall 2000 and incorporated into the soil eight weeks after planting. Russet Burbank was planted in the spring, and yield was recorded at harvest. There was a significant reduction in root knot nematode infested tubers in the green manure crop planted plots as compared to fallow. It reduced from 7.2 percent in the fallow plots to .5 percent in the green manure planted plots. Market yield and total yield was also increased by the green manure crops, though it is not statistically significant.

Soil samples were collected in Bingham County, by Extension Educator Brian Finnigan, for nematode analysis from a field planted with a green manure crop and later planted with potato. Data indicated that the nematode population considerably decreased after planting a green manure crop. Although the nematode population increased after planting potato, the increase was very low as compared to the initial nematode population. Nematode analysis from another field, which had higher and lower densities of oil radish, showed the nematode population to be very low in the plots with the higher stand of oil radish as compared to the lower stand. But, the population reduction was more in both plots as compared to the field not planted with oil radish or planted with pea.

Egg Hatching Study

A study was conducted under controlled conditions to evaluate the effectiveness of new rapeseed and mustard hybrids on reducing egg hatch of root-knot nematode (*Meloidogyne chitwoodi*). Seeds of the hybrid were planted in 100 cc pots filled with steam-sterilized sand-soil mix at the rate of 10 seeds per pot. After germination, the number of plants per pot was thinned and maintained at 5 plants per pot. Experiment was laid out in a completely randomized block design with four hybrids of twenty replications each with an untreated check. One month after planting, eggs of *M. chitwoodi* (300/mesh) coated with gel on 10x10 wire mesh were placed in the soil. The wire mesh with eggs was removed at weekly intervals for four weeks and the eggs counted under a binocular microscope. From the number of eggs that hatched, percent egg hatching due to the rapeseed and mustard hybrids was calculated. The overall egg hatch by the treatment with different cultivars of rape and mustard are not statistically significant as compared to the control.

Validation And Revision Of Economic Threshold Level

Experiments were conducted in a green house to find out the economic threshold level of *M. chitwoodi* on potato crop. The experiment was in a randomized block design with five treatments of five replications each. Potato seed was planted in each pot at the rate of one seed per pot and inoculated with *M. chitwoodi* IJ2 at the logarithmic series of 1, 2, 4, and 8 per cc of soil in each pot with an uninoculated control. At maturity, the crop was harvested and data on the number of tubers infested with the nematode were calculated. Data indicated that inoculation of nematodes at all inoculum levels produced infected tubers.

Chemical Management

A field experiment was conducted to study the efficacy of Mocap along with Temik on the control of Columbia root-knot nematode in a potato field. Experimental design was a randomized block with thirteen treatments of seven replications each including an untreated check. Potato cv. Russet Burbank was planted in April, 2001, in 15 x 50 ft plots. Preplant population of *Meloidogyne* and *Pratylenchus* was estimated. Potatoes were harvested in September, 2001, and yield of different categories was recorded.

Yield of potato tubers under different treatments indicated that there is an increase in market yield and total yield by the different combinations of Temik and Mocap as compared to control plots. Percent of nematode tuber infection ranged from 3.9 to 13.4.

The lowest level of nematode infestation was observed in the treatment of 37.5 gal Vapam HL (3 tier shanks) + 2 gal Mocap (PPI).

Another experiment was conducted to determine if different formulations of Fosthiazate along with Mocap are effective in reducing the nematode population and increasing tuber yield. The experimental design was a randomized block with seven replications. Plot size was 15 x 50 ft. Immediately following application, the field was disked once, harrowed with a Triple K implement twice, bedded on 36 inch rows for potatoes, and planted with Russet Burbank potato on 10 inch drop spacing within the row. Potatoes were harvested on September. Yield samples were taken and graded into five categories for size and appearance. Data indicated that application of Fosthiazate along with Vapam significantly increased the marketable yield of tubers as compared with the untreated check. Percent of infection decreased to 2 percent when compared to 50.9 percent infestation in the control as a result of treatments. However, no significant difference was observed between the untreated control and treated plots in terms of total yield.