# NEMATODE MANAGEMENT OPTIONS FOR SUSTAINABLE POTATO PRODUCTION IN IDAHO

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Nematode surveys conducted in Idaho revealed that eighty five species of plant parasitic nematides belonging to 32 genera have been recorded on 31 host plants from 21 counties. Of which, 37 species and 15 genera are new records in this region. Over all, 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.).

## IMPACT OF ROOT KNOT NEMATODE ON POTATO CULTIVATION

Root-knot nematodes (*Meloidogyne* spp.) have been recognized as a major nematode pest on potato and 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*). 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. They 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. They cause field damage that is localized, usually in circles of various sizes, or spread throughout an entire field with plants becoming chlorotic and stunted. 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 includes alfalfa (*M. hapla*), wheat (*M. chitwoodi*), and other crops that are commonly grown in rotation with potato in Idaho and eastern Oregon and Washington.

## MANAGEMENT STRATEGY

Root-knot nematodes can be effectively managed by adopting chemical, biological and cultural practices. Green manure crops are one of the safest biological practices to control the root-knot nematode on potatoes. In addition to reducing soil densities of nematode population, other benefits of using green manure trap crops include increased yields of subsequent potato crops, improved soil tilth and water holding capacity, reduced nitrogen leaching into groundwater, weed suppression, reduced soil erosion by wind and water, and suppression of soil born diseases. To effectively reduce nematode populations, green manure crops require at least eight weeks growth and can be planted either in early spring or late summer. Often, they can be conveniently planted after the grain harvest. Further studies are needed to find out the nematode suppression effects of newly developed

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green manure crops under Idaho conditions. Temik offers a valuable chemical suppression of root-knot nematode species. If root-knot nematode is a severe economic pest, the use of other nematicides such as metam sodium, Telone II, or Mocap should also be employed. Further, application of Mocap either during fall or spring along with Vapam, significantly reduced the nematode infested potatoes as compared to untreated check. However further studies are needed to improve the application rate, efficacy of these nematicides in combination with other nematicides, and to find out the optimum application time along with suitable cultural practices.

Integrated Nematode management (INM) on potato 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 potato nematodes. 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, development of nematode resistance to available nematicides, decreased availability of labeled nematicides, and the need for economically viable management strategies.

INM on potato crop can be achieved by adopting the following strategies at appropriate levels.

- Evaluate the efficacy of new oil radish varieties to suppress the population of root knot nematode on potato and their invitro inhibition on root knot nematode egg hatch.
- Determine the resistant reaction of bean and alfalfa cultivars to root-knot nematodes and include them as a rotational crop in the cropping system.
- Determine different combination of chemical options for the sustainable potato nematode management.

## I. SCREENING OF BEAN CULTIVARS

Earlier studies in our lab indicated that the Brazilian dry bean cultivar Apore is resistant to Columbia root knot nematode *M.chitwoodi*. Therefore, Apore was backcrossed with the breeding line USAPT-73 and the 30 F1 seeds from this cross were screened for Columbia root knot nematode resistance in the green house. Experimental design was a completely randomized block design with 30 cultivars of seven replications each. Single seed of each cultivar was planted 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, plants were uprooted, nematodes were extracted from roots of each cultivar, 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 varied 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 this study 11 lines were showing minimum root population as compared to four other lines selected for this study.

## II. SCREENING OF ALFALFA GENOTYPES

An experiment was conducted under green house conditions to evaluate the tolerance level of sixteen alfalfa cultivars to the lesion nematode *P. penetrans*. Cones of 150 cc capacity were filled with sterilized soil and seeds of each of alfalfa cultivar were planted in each cone. After germination, seedlings were thinned to three per cone and inoculated with *P. penetrans*, maintained on corn roots in tissue culture, at the rate of 100 nematodes per container. 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. In this experiment there was a significant difference in the parameters between these cultivars as compared to the cultivar Baker, a susceptible host. Data indicated that the variety ZG 0245A and ZC 0256A showed the minimum nematode population in the soil, while ZG 0250A had minimum population in the root. Maximum fresh root weight and shoot weight was observed in the variety 6530. In the second experiment 12 alfalfa cultivars were tested for tolerance to the Columbia root knot nematode. There was a significant difference in the parameters as compared to the root knot nematode susceptible cultivar Lahontan. In ZL 0051A fresh and dry weight of shoot, as well as roots, were significantly higher, and the nematode population in the soil and root was minimum.

## III. GREEN MANURE STUDIES

Cultivars of oil radish and mustard were tested for their potential to reduce the root knot nematode population and improvement of potato parameters under field conditions. The experiment was in a Randomized Block Design with five treatments of six replications each. Cultivars of oil radish (colonel, commodore) rape (humus) and lentil (redchief) were planted on August 11, 2002, in a root knot nematode infested field during fall in Parma, Idaho. Eight weeks after planting, samples were collected for biomass evaluation, and the fresh and dry weights of the crops were estimated. Potatoes will be planted in the spring, 2004. Biomass accumulation data proved that oil radish commodore and Colonel produced the maximum biomass as compared to lentil Redchief.

## CHEMICAL MANAGEMENT

## IV. CHEMICAL MANAGEMENT OF ROOTKNOT NEMATODES BY VAPAM

A field experiment was conducted at the Parma Research and Extension Center to study the efficacy of Mocap EC and Vapam (tank mix) compared to Admire, Telone II, Mocap alone for control of Columbia root knot nematode in potato. The experiment was laid out in a randomized complete block design with seven treatments each with six replications in a sandy loam field. Mocap and Vapam (tank mix) treatments were applied

by commercial fumigation applicator on October 24, 2002, or April 21, 2003. Telone II was applied as broadcast on October 28, 2002, by ripper bar. Mocap alone was applied on April 21, 2003, using a hand held sprayer with 8002 flat fan nozzles at 50 psi calibrated to deliver 34.5 gallons per acre. Within one hour of application, all plots were disked twice to incorporate the chemicals. Temik and Admire were applied at planting. Potato cv. Russet Burbank seed pieces were planted on April 23, 2003, in rows three feet apart. Five months after planting, the tubers were hand-harvested on September 18, 2003, from 15 feet of the middle two rows of each plot and weighed. Yield of tubers from different treatments indicated that there was an increase in marketable yield and total yield in different combinations of all treatments as compared to control plot. Nematode infected tubers as well as percent of nematode infection were also significantly reduced by the treatments as compared to control plots. The lowest level of nematode infection was recorded with the fall or spring application of Mocap+Vapam(tank mix) compared to other treatments. The percentage of tubers with nematode infection in treated plots ranged from 8.6 to 91.9.

## V. EVALUATION OF NEMATICIDES FOR THE MANAGEMENT OF COLUMBIA ROOT-KNOT NEMATODE

Another experiment was conducted at the Parma Research and Extension Center, Parma, Idaho to demonstrate the efficacy of Telone II and different rates of Vapam alone and along with Mocap on the management of Columbia root knot nematode and yield of potato. The experiment was laid out in a randomized complete block design with five treatments each with six replications in a sandy loam field. Mocap + Vapam (tank mix) was applied on October 24, 2002, or April 21, 2003, and Mocap alone was surface broadcast on April 21, 2002, using a commercial fumigation applicator. Within one hour of application, all plots were disked twice to incorporate the chemicals. Telone II was applied as broadcast on October 28, 2003, by ripper bar. Potato cv. Russet Burbank seed pieces were planted on April 23, 2003, in rows three feet apart. Plant protection, weeding and other standard cultural practices were followed. Five months after planting, the tubers were hand-harvested on September 17 from 15 feet of the middle two rows of each plot and weighed. The tubers were graded and evaluated for nematode infection. The yield of tubers from different treatments indicated that there is an increase in marketable yield and total yield in different combinations of Vapam and Mocap (tank mix), as compared to control plot. The percentage of tubers with nematode infection in treated plots ranged from 17.3 to 48.0 as compared to untreated control. The lowest level of nematode infection was observed in the tank mix spring application of 2 gal Mocap +37.5 gal Vapam.

## VI. RATE STUDY OF VAPAM FOR THE CONTROL OF ROOT KNOT NEMATODE

In another experiment, efficacy of different rates of Vapam were evaluated for the control of Columbia root-knot nematode in potato. Vapam was applied by fumigation bar on October 24, 2002, to individual plots (15 x 50 ft) in randomized complete block design with six replications. Potato seed pieces were planted on April 23, 2003, in rows three

feet apart. Five months after planting, tubers were hand-harvested on September 18, 2003, from 15 feet of the middle two rows of each plot and weighed. The tubers were graded and evaluated for nematode infection. Data indicated that application of Vapam at all rates significantly increased the marketable and total yield of tubers and reduced the nematode infected tubers and percent of nematode infection as compared to control plots. However there is no significant difference in the reduction of percent nematode infection among the treatment rates applied. The lowest level of nematode infection was observed in the plots treated with Vapam 80 gal/A. Nematode infection ranged from 8.1 to 21.3 in the treated plots compared to 91.6 % in the control plot.

## VII. FOSTHIAZATE 500 EC FOR CONTROL OF COLUMBIA ROOT-KNOT NEMATODE

In another experiment the efficacy of Vapam HL along with fosthiazate 500 EC was evaluated for control of Columbia root-knot nematode in potato. Treatments were broadcast applied to individual plots (15 x 50 ft) in randomized complete block design with six replications. Vapam was broadcast by fumigation bar on October 24. Fosthiazate treatments were surface broadcast on April 21 using a hand held sprayer with 800 Z flat fan nozzles at 50 psi calibrated to deliver 34.5 gallons per acre. Within one hour of application, all plots were disked two times to incorporate the chemical. Potato seed pieces were planted on April 23 in rows three feet apart. Five months after planting, tubers were hand-harvested on September 18 from 15 ft of the middle two rows of each plot and weighed. The tubers were graded and evaluated for nematode infection. All chemical treatments significantly increased the marketable yield of tubers and reduced nematode infested tubers, compared to untreated control. The percentage infection as a result of treatments was reduced below 11.6.0 % when compared to 99.9 % infection in the control. No significant difference could be observed between the untreated control and treated plots in terms of total yield**.**

## VIII. EVALUATION OF TWO RATES OF TELONE II AND OTHER NEMATICIDES FOR THE MANAGEMENT OF COLUMBIA ROOT-KNOT NEMATODE

In another study, efficacy of Vapam HL and Telone II combination with Temik 15G or Mocap EC or Vydate L (fall or spring) or Fosthiazate were evaluated for control of Columbia root knot nematode in potato. The experiment was laid out in a randomized complete block design with thirteen treatments each with seven replications in a sandy loam field. Fosthiazate and Mocap treatments were surface broadcast on April 21, 2003, using a hand held sprayer with 8002 flat fan nozzles at 50 psi calibrated to deliver 34.5 gallons per acre. Within one hour of application, all plots were disked twice to incorporate the chemicals. Telone II and Vapam were applied as broadcast on October 28 and October 24, 2002, by ripper and fumigation bar, respectively. Temik 15G was applied at planting. Vydate L was applied followed by a short irrigation starting at 1800 DD and 2 week intervals as a foliar spray, using a handheld boom sprayer with 8002 flat fan nozzles calibrated to deliver 26 gal/acre at 40 psi. Potato cv. Russet Burbank seed pieces were planted on April 23, 2003, in rows three feet apart. Five months after

planting, the tubers were hand-harvested on September 18, 2003, from 15 feet of the middle two rows of each plot and weighed. The yield of tubers from different treatments indicated that there was an increase in marketable yield and total yield in different combinations of all treatments as compared to control plot. Nematode infected tubers as well as percent of nematode infection were also significantly reduced by the treatments as compared to control plots. The percentage of tubers with nematode infection in treated plots ranged from 11 to 99.6.

## IX. EVALUATION OF TELONE II ALONE AND COMBINATIONS WITH VAPAM FOR THE MANAGEMENT OF COLUMBIA ROOT-KNOT NEMATODE

A study was conducted to demonstrate the effects of Telone II alone and in combination with Vapam on nematode management and yield of potato. The experiment was laid out in a randomized complete block design with five treatments each with six replications in a sandy loam field. Mocap treatments were surface broadcast on April 21, 2002, using a hand held plot sprayer with 800 Z flat fan nozzles at 50 psi calibrated to deliver 34.5 gallons per acre. Telone II and Vapam were applied as broadcast on October 28 and October 24 by ripper and fumigation bar, respectively. Potato cv. Russet Burbank seed pieces were planted on April 23 in rows three feet apart. Five months after planting, the tubers were hand-harvested on September 17 from 15 feet of the middle two rows of each plot and weighed. The yield of tubers from different treatments indicated that there was an increase in marketable yield and total yield in different combinations of Temik and Mocap, as compared to control plot. The percentage of tubers with nematode infection in treated plots ranged from 3.9 to 13.4. The lowest level of nematode infection was observed in the treatment of 37.5 gal Vapam (3 tier shanks) + 2 gal Mocap.