

POTATO NEMATODE MANAGEMENT TACTICS WITH BIOLOGICAL AND CHEMICAL STRATEGIES

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Nematodes are one of the major limiting factors for potato production in the Pacific Northwest. Nematode infestation results in yield decline and reduction in quality, thereby contributing economic loss to the industry. Predominant nematode pests identified in rhizospheres of potatoes are root-knot nematodes (*Meloidogyne* spp.), root-lesion nematodes (*Pratylenchus* spp.), and stubby-root nematodes (*Trichodorus* and *Paratrichodorus* spp.). There is an interaction between *Pratylenchus* spp. and Verticillium wilt. Nematodes are also a concern to potato growers because they are vectors of tobacco rattle virus.

Integrated nematode management 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. 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 field level.

Green manure crops (crops that are incorporated while still green) can be used early during the preplant stage. Oil radish is planted in the fall before planting the potato crop the following spring. These green manure crops are incorporated into the soil before “freeze-up.” Consistent application of manures (organic matter) results in some nematode control. High ammonia concentrations improve efficacy. Manure also helps with beneficial organisms, which can suppress the nematode population.

Root-knot nematodes (*Meloidogyne* spp.) are of particular concern to the potato industry. Columbia root-knot nematode (*Meloidogyne chitwoodi*) and Northern root-knot nematode (*M. hapla*) are endoparasites that are found in abundance in many areas, especially in sandy soils, and have been recognized as pests in potatoes for a long time. Infestation can render tubers unmarketable. When the level of infected tubers exceeds 10%, processors and packers generally reject all potatoes from that field. These nematodes have a wide host range leading to population increases. Preplant fumigation with 1, 3 dichloropropene (Telone II), or metam sodium (Vapam, Metam, Busan) is an effective management tool. Aldicarb (Temik) applied at planting in combination with ethoprop (Mocap) can also be an effective treatment. Effective weed control is important before and during potato culture because the nematodes have many weed hosts and are able to multiply on these hosts quickly. For Columbia root-knot and northern root-knot nematodes, growers treat with non fumigant nematicides ethoprop (Mocap), aldicarb (Temik) when populations are relatively low, but fumigation is necessary if population counts exceed 50.

Because aldicarb (Temik) is a systemic product, it is highly effective in controlling the root-lesion nematodes that feed inside the root system (endoparasites). Aldicarb (Temik), applied at planting,

remains in the root system and soil profile for 6 to 8 weeks. When eggs hatch, this long residual action provides good nematode control. Research at the University of Idaho shows that controlling root-lesion nematode populations has a positive impact on tuber yield. Twenty pounds of aldicarb (Temik) applied at planting significantly reduced root-lesion nematode populations and increased tuber yield an average of 38.3 cwt/A. Years of research and grower experience along the Snake River Plain of Southern Idaho have also proven that aldicarb (Temik) applications often result in verticillium wilt (early die) suppression with an accompanying yield response. These results may be due to several positive effects caused by aldicarb (Temik) including root-lesion nematode control, a negative impact on the development of *Verticillium microsclerotia* or beneficial plant growth regulatory effects. Treatment thresholds for aldicarb (Temik) have been developed. The threshold for *P. neglectus* is when counts are 2000 nematodes per 500cc soil in fields with no history of early die. If early die is present, the threshold for treatment is when *P. neglectus* counts reach 100. In fields infected with *P. penetrans*, the treatment threshold is 100, regardless of the early die situation.

Stubby-root nematodes (*Paratrichodorus* spp.) are important for two reasons: 1) these nematodes are the vector for the tobacco rattle virus which causes corky ringspot disease, and 2) they are difficult to control because of their mobility in the soil. This nematode is highly sensitive to change in soil moisture and temperature. Fluctuations in these two factors causes the nematode to move up and down in the soil profile. Stubby-root nematodes can reside at soil depths of more than 40 inches. When these nematodes migrate deep in the soil profile, they are difficult to control. Because ethoprop (Mocap) and metam sodium (Vapam, Metam, Busan) are contact nematicides, their application does not effectively control stubby-root nematodes. 1,3-dichloropropene (Telone II) must be applied at high usage rates, which result in increased input costs. Aldicarb (Temik) application at 20 lbs/A is very effective in controlling stubby-root nematode. Aldicarb's (Temik) systemic activity also affects nematodes as they feed on the root system of treated potato plants. Efficacy of the nematicides on stubby-root nematode differs with respect to application method in the field. Aldicarb (Temik) applied in-furrow at planting, modified in-furrow at planting or in-furrow at planting in combination with foliar applications of oxamyl (Vydate) resulted in the lowest incidence of corky ring spot disease and had the highest total and marketable yields. Corky ring spot incidence, ranging from 6 to 55%, resulted in significant differences in total and marketable yields. Oxamyl (Vydate) is a systemic nematicide, hence it is very effective in controlling all nematodes. However, the sensitivity of oxamyl (Vydate) to pH is the major constraint that restricts the use of this nematicide. Also, oxamyl (Vydate) has a short half-life requiring multiple applications during the growing season. Oxamyl (Vydate) is more effective when used in combination with other nematicides such as aldicarb (Temik) or ethoprop (Mocap) at planting.

Considering the importance of nematode pests, following studies were conducted to effectively manage them on potato.

I. GREEN MANURE STUDIES

Efficacy of cultivars of oil radish and rapeseed were tested to include them in the long term rotation practices. Cultivars of oil radish (Colonel and Commodore) and lentil (Redcliff) were planted August, 2003. Before planting of green manure crops, the nematode population among the treatments was similar and differences observed were not statistically significant. The maximum reduction of root knot nematode population was observed as a result of planting oil radish Colonel (80.9%) when compared to the less effective Commodore (67.3%). Greater biomass was recorded in the oilradish planted plots as compared to lentil. In the spring of 2004, potatoes were planted and the yield data at harvest indicated that there was a significant reduction

in root knot nematode infested tubers in the green manure crop planted plots as compared to fallow (table 2). Infestation was reduced from 84.2% in the fallow plots to 37% in the green manure planted plots. Marketable and total yield also increased by use of green manure crops as compared to fallow treatment.

In another green house experiment, efficacy of new oil radish varieties were compared for the multiplication of *M.chitwoodi*. Six varieties of oilradish were planted on May 7, 2004 in a completely randomized block design with five replications each. The crop was harvested on July 2, 2004 and data on fresh and dry weight of shoot and root along with the nematode population in the soil and per g of root were recorded. Data indicated that, among all varieties, Comet showed maximum fresh and dry weight of shoot and root. Lowest level of total nematode population in the root and the maximum percent of reduction of root population (98.7) were also observed in the Comet variety.

II. EGG HATCHING STUDY

A study was conducted under controlled conditions to evaluate the effectiveness of rapeseed and mustard hybrids on reducing egg hatch of Columbia root-knot nematode (*Meloidogyne chitwoodi*). Three treatments (rapeseed root exudate, mustard root exudate, and water), replicated five times, were compared to determine the effect of exudates on *M. chitwoodi* egg hatch. Root extracts were collected at weekly intervals for four weeks. The overall egg hatch by the treatment with different cultivars of rape and mustard were progressively reduced compared to the control.

CHEMICAL MANAGEMENT

III. CHEMICAL MANAGEMENT OF COLUMBIA ROOT NEMATODE

A field experiment was conducted at the Parma Research and Extension Center, Parma, Idaho to study the efficacy of a new product KC 791230 alone and in combination with Vapam or Mocap, for control of Columbia root knot nematode in potato. The experiment was laid out in a randomized complete block design with nine treatments, each with six replications, in a sandy loam field. Mocap was applied on April 19, 2004, 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. Vapam was applied broadcast on October 20, 2004, by fumigation bar shanks with sweep to a depth of 8-10" by commercial applicator. Temik and KC 791230 were applied at planting. Vydate L was applied starting at 1800 DD and at 2 week intervals, using a plot chemigation springler set to deliver one inch of water in a 6 foot by 25 foot plot. Potato cv. Russet Burbank seed pieces were planted on April 20, 2004, 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 13, 2004, from 20 feet of the middle two rows of each plot and weighed. The tubers were graded and evaluated for nematode infection. 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 in the Vapam 30 gal/ A + Mocap 2gal/A, with the maximum clean yield than other treatments. Percent of tubers with nematode infection in treated plots ranged from 5.6 to 38.7.

IV. EFFICACY OF TELONE II COMPARED WITH OTHER NEMATOCIDES

A field experiment was conducted at the Parma Research and Extension Center, Parma, Idaho to study the efficacy of Telone II alone or in combination with Vapam HL for control of Columbia root-knot nematode in 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 19, 2004, using a hand held sprayer with 8002 flat fan nozzles at 50 psi calibrated to deliver 34.5 gpa. Within one hour of application, all plots were disked twice to incorporate the chemicals to a depth of 4-6". Telone II and Vapam were applied broadcast on October 20, 2004, by ripper and fumigation bar to a depth of 16-18" and 8-10" respectively. Potato cv. Russet Burbank seed pieces were planted on April 20, 2004, in rows three ft apart. Plant protection practices, weeding and other standard cultural practices were followed. Five months after planting, the tubers were hand-harvested on September 13, 2004, from 20 feet of the middle two rows of each plot and weighed. The tubers were graded and evaluated for nematode infection. 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 the control plots. Nematode infected tubers as well as percent of nematode infection were also significantly reduced by the treatments as compared to control plots. Percent of tubers with nematode infection in treated plots ranged from 6.2 to 41.6. The lowest level of nematode infection was recorded in the Telone 15 g/A + Vapam 30 gal/A, which also gave the maximum marketable yield compared to the other treatments.