CURRENT STATUS OF ROOT-KNOT, ROOT-LESION AND STUBBY-ROOT NEMATODES ON POTATOES

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The Columbia (Meloidogyne chitwoodi) and northern (M. hapla) root-knot nematodes remain a serious problem to potato production by blemishing tubers. Both species causes brown spots within the vascular ring of the tuber, but only M. chitwoodi produces wart-like bumps on the surface of the tubers. M. chitwoodi is more important than M. hapla because it is able to produce 4-5 generations compared to 2-3 for M. hapla (1). Thus, later in the season much higher population densities of M. chitwoodi are present in the soil to attack tubers.

We continue to investigate the best means to utilize currently available nematicides for control of M. chitwoodi. For the past several years we have been evaluating the use of shank-injected Telone II or metham sodium in combination with water applied metham sodium. The rationale is that the shank-injected fumigants will control the deep placed nematodes, and metham sodium applied in 1/2-inch of water will control nematodes as well as other disease pathogens and pests near the surface.

In 1992 two field trials were conducted at IAREC, Prosser and Agri-Northwest, Inc., Plymouth, Wa. to evaluate various soil fumigation treatments for control of M. chitwoodi on Russet Burbank potato. Treatments included metham sodium at 55 gal/A applied in 1-inch of water, Telone II 10 gal followed by metham sodium 40 gal in 1/2-inch water, metham sodium 55 gal applied with shanks, metham sodium 55 gal shank followed by metham sodium 20 and 40 gal in 1/2-inch water, metham sodium 35 and 45 gal shank followed by 20 gal in 1/2-inch water, and shank-injected metham sodium 55 gal mixed with 55 gal water. Telone II at 20 gal/A served as a standard check, and untreated plots served as controls. Telone II was applied as a broadcast by tractor-drawn chisels 18 inches deep, spaced 18 inches apart and packed immediately with a cultipacker. Metham sodium was applied in 1-acre-inch of water, and metham sodium in combination with Telone II or shanked metham sodium treatments were applied in 1/2-inch of water through an overhead irrigation simulator. Metham sodium shank treatments were applied as a broadcast spray at 18 inches deep with V-shaped sweep shanks. A spray nozzle was attached below each shank to dispense the material.

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Nematode soil population densities were monitored during the growing season. Nematode counts, yield and tuber infection data were obtained from the middle row (30 ft.) of each plot. Forty tubers were selected at random and evaluated for external symptoms, and 20 of these tubers were peeled by hand and examined for nematode infection. Tubers were rated for nematode infection in terms of percent cullage (any tuber with six or more nematode infection sites) and infection index from hand peeled tubers. Plots at Prosser were planted May 18 and harvested October 8, and plots at Agri-Northwest, Inc. were planted May 6 and harvested September 28, 1992.

In the Prosser trial all nematicide treatments, except the sprinkler applied metham sodium reduced ($P < 0.05$) M. chitwoodi population densities (Table 1). Yields in the metham sodium sprinkler, metham sodium shank, metham sodium 35 gal shank + 20 gal sprinkler, and metham sodium + water did not differ significantly ($P < 0.05$) from the untreated (Table 2). All other treatments had higher yields than the untreated. Excellent control of M. chitwoodi was achieved with all of the nematicide treatments, except metham sodium sprinkler treatment (Table 2). In the plots at Agri-Northwest, Inc. only the sprinkler applied metham sodium and metham sodium 45 gal shank + metham sodium 20 gal sprinkler did not reduce ($P < 0.05$) nematode population densities at harvest (Table 3). All treatments significantly ($P < 0.05$) increased yields compared to the untreated (Table 4). Excellent control of M. chitwoodi was achieved with the Telone II + metham sodium, metham sodium 55 gal shank + 40 gal water treatments, and metham sodium 55 gal shank + 20 gal water (Table 4). None of the other treatments including Telone II 20 gal gave adequate control. In this trial the Telone II plots were sealed with 1/2-inch of water after application, and cultipacked 24 hrs later. Failure to cultipack soon after application probably had a significant effect on the performance of Telone II. The differences in control between the two trials was probably due to the higher initial M. chitwoodi population densities in the plots at Agri-Northwest, Inc. (Table 3) compared to Prosser (Table 1).

Results from nematicide trials over the years show that the combinations of Telone II 20 gal/A plus Mocap 10G 12 lbs ai/A (seven trials), Telone II 10 gal plus metham sodium 40 gal/A (1/2-inch water) [six trials], and metham sodium 55 gal/A (shank) plus metham sodium 40 gal/A (1/2-inch water) [three trials] have given consistent control of M. chitwoodi (2,3,4,5).

The root-lesion nematodes Pratylenchus penetrans and P. neglectus are commonly found in eastern Washington. Pratylenchus neglectus appears to be native to this region and is the most common root-lesion nematode species in the potato growing areas. P. penetrans is most commonly associated with tree fruit and mint plantings, and may be found on potato following these crops. Our studies indicate that these nematodes alone are of minor economic importance on potato. However, the root-lesion nematodes may play a more important role in the potato early dying disease.

Potato early dying is believed to be caused primarily by the soil-borne wilt fungus Verticillium dahliae.

However, other fungi (Colletotrichum coccodes, Rhizoctonia solani and Fusarium spp.), soft-rot bacteria (Erwinia carotovora subsp. carotovora and E. carotovora subsp. atroseptica), and plant parasitic nematodes (Pratylenchus spp., Meloidogyne hapla, and Globodera rostochiensis [in the U.S. known to occur only in New York.]) have been implicated in the disease complex.

We conducted field microplot studies to determine the involvement of P. neglectus and P. penetrans with V. dahliae and E. carotovora subsp. carotovora in the early dying disease of Russet Burbank potato. Results showed that early dying foliage symptoms occurred earlier and were most severe whenever either nematodes occurred together with the fungus and bacteria as compared to each alone or any two in combination. Tuber yields in 1990 and 1991 were reduced an average of 70% when all three organisms occurred together, 36% for any two in combination, and 14% for any organism alone (Fig. 1). This is the first report demonstrating the importance of P. neglectus in potato early dying. This is significant because P. neglectus is the most prevalent root-lesion nematode in the potato growing regions of the Pacific Northwest.

The stubby-root nematodes (Paratrichodorus and Trichodorus spp.) can be as important on potatoes as the root-knot nematodes. Certain species of these nematodes are able to transmit the tobacco rattle virus into the potato plant during tuberization, which results in the corky ringspot disease. This virus disease causes internal damage and renders the tubers unmarketable. The typical tuber symptoms are brown necrotic rings and arcs that extend deep into the flesh and frequently break through the skin producing finely-fissured, corky, surface areas. In recent years the numbers of potato crops damaged by this disease have increased. This has coincided with the voluntary withdrawal of Temik for use on potatoes in 1989. Temik is effective against the stubby-root nematodes, and was the most effective nematicide for control of the corky ringspot disease on potato in Florida (6). The extensive use of Temik for insect control has probably prevented the occurrence of this disease in many potato fields in the Pacific Northwest.

Chemical control studies in Umatilla, Oregon (see report by R. E. Ingham, Corky ringspot - What control measures are available?) indicates that Telone II gives better control of the corky ringspot disease then Temik, and metham sodium does not appear to control this disease. In 1992 several potato fields damaged by corky ringspot in Washington were treated with metham sodium. Of the nonfumigant nematicides, it appears that the carbamates such as Temik controls the stubby root nematodes better than the organophosphates like Mocap.

Literature Cited

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Table 1. Pretreatment, post-treatment, midseason and harvest Meloidogyne chitwoodi juvenile counts per 250 cm^3 of soil from metham sodium potato plots, Prosser, Wa. 1992.

Treatment (rate/A)[1]	Apr 1	Sept 15	Oct 14
Untreated	35 a	489 a	1189 a
Telone II 20 gal	138 a	3 b	4 b
Metham 55 gal (1-inch)	150 a	1349 a	2204 a
Metham 55 gal (shank)	87 a	2 b	4 b
Telone II 10 gal + Metham 40 gal (½-inch)	192 a	3 b	9 b
Metham 55 gal (shank) + Metham 20 gal (½-inch)	46 a	1 b	4 b
Metham 45 gal (shank) + Metham 20 gal (½-inch)	14 a	2 b	4 b
Metham 35 gal (shank) + Metham 20 gal (½-inch)	37 a	2 b	17 b
Metham 55 gal (shank) + Metham 40 gal (½-inch)	79 a	0 b	11 b
Metham 55 gal + 55 gal water (shank)	37 a	2 b	2 b

Values are means of five replicates. Values in each column followed by the same letter do not differ at $P < 0.05$, according to least significant difference (LSD) test. Data were transformed to $LOG_e(X+1)$.

[1] Metham sodium sprinkler treatments applied in ½ or 1-inch of water. Telone II shank treatments injected 18 inches deep, and metham sodium shank treatments applied 18 inches in a broadcast spray.

Table 2. Russet Burbank potato tuber yields, % infection, % culls, and infection index of Meloidogyne chitwoodi from metham sodium plots, Prosser, Wa. 1992.

Treatment (rate/A)[1]	Yield (T/A)	% culls[2]	Inf. index[3]
Untreated	25.6 d	83.1 b	4.30 b
Telone II 20 gal	33.0 ab	0.0 c	0.04 c
Metham 55 gal (1-inch)	27.4 bcd	99.6 a	5.53 a
Metham 55 gal (shank)	31.0 a-d	0.04 c	0.19 c
Telone II 10 gal + Metham 40 gal (½-inch)	34.9 a	0.0 c	0.03 c
Metham 55 gal (shank) + Metham 20 gal (½-inch)	33.5 a	0.01 c	0.07 c
Metham 45 gal (shank) + Metham 20 gal (½-inch)	31.5 abc	0.0 c	0.04 c
Metham 35 gal (shank) + Metham 20 gal (½-inch)	29.5 a-d	0.04 c	0.09 c
Metham 55 gal (shank) + Metham 40 gal (½-inch)	33.1 ab	0.01 c	0.06 c
Metham 55 gal + 55 gal water (shank)	26.0 cd	0.01 c	0.09 c

Values are means of five replicates. Values in each column followed by the same letter do not differ at $P < 0.05$, according to least significant difference (LSD) test. Data were transformed to ARCSIN[SQRT(X)].

[1] Metham sodium sprinkler treatments applied in ½ or 1-inch of water. Telone II shank treatments injected 18 inches deep, and metham sodium shank treatments applied 18 inches in a broadcast spray.

[2] % culls: any tuber with 6 or more infection sites were graded as culls.

[3] Infection index: 0 = no infection sites; 1 = 1-3; 2 = 4-5; 3 = 6-9; 4 = 10+; 5 = 50+; and 6 = 100+ nematodes per tuber.

Table 3. Pretreatment, post-treatment, midseason and harvest Meloidogyne chitwoodi juvenile counts per 250 cm^3 of soil from metham sodium plots, Agri-Northwest, Inc., Prior Land, Plymouth, Wa. 1992.

Treatment (rate/A)[1]	Mar 27	Sept 2	Sept 30
Untreated	589 a	4452 a	3159 a
Telone II 20 gal	940 a	18 c	117 ef
Metham 55 gal (1-inch)	550 a	1676 a	2338 ab
Metham 55 gal (shank)	1182 a	133 b	788 bcd
Telone II 10 gal + Metham 40 gal (½-inch)	1482 a	5 cd	7 g
Metham 55 gal (shank) + Metham 20 gal (½-inch)	680 a	5 cd	44 f
Metham 45 gal (shank) + Metham 20 gal (½-inch)	1861 a	239 b	1124 abc
Metham 35 gal (shank) + Metham 20 gal (½-inch)	1402 a	113 b	407 cde
Metham 55 gal (shank) + Metham 40 gal (½-inch)	935 a	1 d	46 f
Metham 55 gal + 55 gal water (shank)	1753 a	135 b	242 de

Values are means of five replicates. Values in each column followed by the same letter do not differ at $P < 0.05$, according to least significant difference (LSD) test. Data were transformed to $LOG_e(X+1)$.

[1] Metham sodium sprinkler treatments applied in ½ or 1-inch of water. Telone II shank treatments injected 18 inches deep, and metham sodium shank treatments applied 18 inches in a broadcast spray.

Table 4. Russet Burbank potato tuber yields, % infection, % culls, and infection index of Meloidogyne chitwoodi from metham sodium plots, Agri-Northwest, Inc., Prior Land, Plymouth, Wa. 1992.

Treatment (rate/A)[1]	Yields (T/A)	% culls[2]	Inf. Index[3]
Untreated	16.6 b	99.6 a	5.66 a
Telone II 20 gal	23.4 a	18.6 c	1.92 c
Metham 55 gal (1-inch)	23.0 a	90.8 ab	4.84 ab
Metham 55 gal (shank)	21.9 a	94.2 ab	4.59 ab
Telone II 10 gal + Metham 40 gal (½-inch)	22.0 a	0.2 c	0.28 d
Metham 55 gal (shank) + Metham 20 gal (½-inch)	22.3 a	5.9 c	1.09 d
Metham 45 gal (shank) + Metham 20 gal (½-inch)	23.1 a	95.4 ab	4.86 abc
Metham 35 gal (shank) + Metham 20 gal (½-inch)	24.3 a	77.0 b	3.98 c
Metham 55 gal (shank) + Metham 40 gal (½-inch)	22.8 a	0.7 c	0.48 e
Metham 55 gal + 55 gal water (shank)	22.2 a	93.9 ab	4.39 bc

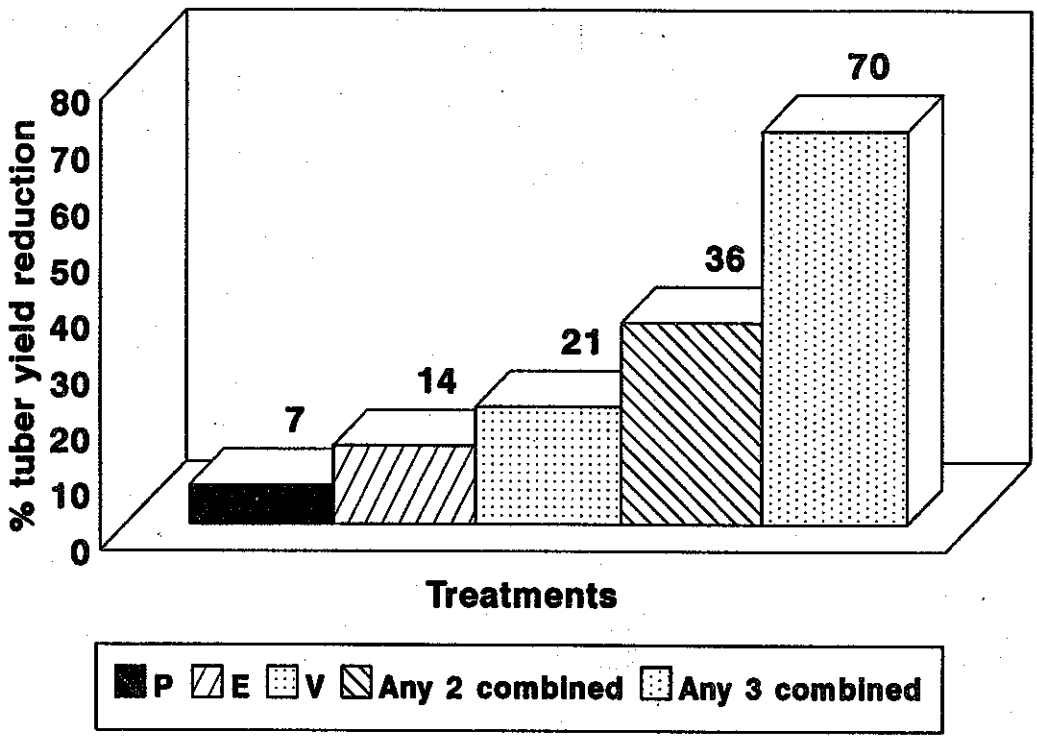
Values are means of five replicates. Values in each column followed by the same letter do not differ at $P < 0.05$, according to least significant difference (LSD) test. Percent data were transformed to ARCSIN[SQRT(X)].

[1] Metham sodium sprinkler treatments applied in ½ or 1-inch of water. Telone II shank treatments injected 18 inches deep, and metham sodium shank treatments applied 18 inches in a broadcast spray.

[2] % culls: any tuber with 6 or more infection sites were graded as culls.

[3] Infection index: 0 = no infection sites; 1 = 1-3; 2 = 4-5; 3 = 6-9; 4 = 10+; 5 = 50+; and 6 = 100+ nematodes per tuber.

Figure 1. Effect of Pratylenchus spp. (P), Verticillium dahliae (V), and Erwinia carotovora subsp. carotovora (E) alone, any two in combination, and all three combined on percent tuber yield reduction of Russet Burbank Potato in field microplots.



Results are averages from 1990 and 1991.
***P. neglectus* and *P. penetrans* results were combined.**