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# Using Nematicides for Suppression of Root-lesion Nematodes And Potato Early-dying

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**Introduction:** Pre-mature vine death or "early dying" is a wide spread problem in Klamath Basin fields where potatoes have been grown for an extended time. Early dying can cause significant yield reductions especially when growing sensitive varieties including Russet Norkotah and Yukon Gold. *Verticillium dahliae* is the primary causal agent of early dying, but *Alternaria solani (*early blight), *Erwinia carotovora* (soft rot), *Colletotrichum coccodes* (black dot), and nematodes also contribute to early dying in California. Studies have shown co-infection of potatoes by both *V. dahliae* and root-lesion nematode, *Pratylenchus penetrans*, can greatly increase the severity of potato early-dying. Tulelake growers currently utilize crop rotation and fumigation to manage early dying. These management practices help suppress early dying, but fungal and bacterial diseases are still prevalent in many fields.

A study was started at IREC in 2013 to investigate the influence of nematicides on suppression of root lesion nematode, *Pratylenchus neglectus* and the resulting effect on potato early-dying. It is important to note that the predominate root lesion nematode species in the Klamath Basin is *Pratylenchus neglectus* which is not known to interact directly with Verticillium; however high populations have been associated with reduced potato growth and early vine decline. Three oxamyl (Vydate) nematicide programs were tested. All oxamyl treatments had a noticeable effect on reducing foliar early-dying symptoms and severity compared to the fungicide only control (2013 progress report). Two nematicide treatments increased average tuber size compared to the control (2013 progress report). All oxamyl treatments had numerically higher yields compared to the control.

Promising results in 2013 persuaded us to expand and replicate the study in 2014 and 2015. Table 1 summarizes the treatments tested both years.

**<u>Study objectives</u>**:

- Evaluate nematicides efficacy for suppression of root lesion nematode and potato early-dying when growing Russet potatoes
- Evaluate nematicide treatments on two potato varieties (Russet Norkotah and GemStar) with varying susceptibility to potato early-dying to determine differences in potato yield and quality for varieties with low and high susceptibility to early-dying.

**Table 1. Treatment list including nematicide, insecticide, and fungicide rates and application timing for 2014 and 2015 studies.**

| | | | | Application Timing | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Trt #** | **Active Ingredient** | **Product Name** | **Product Rate per acre** | **Pre-plant 3 weeks before planting** | **Seed trt** | **In-furrow at planting** | **8 inch rosette** | **Row closure 7 WAP** | **14 days after row closure trt** | **28 days after row closure trt** |
| 1 | fludioxonil | Maxim 4FS | 0.08 oz/100 lbs seed | | X | | | | | |
| 1 | azoxystrobin | Quadris | 0.8 fl. oz/1000 ft | | | X | | | | |
| 1 | fluopyram + pyrimethanil | Luna Tranquility | 11.2 fl. oz/A | | | | | broadcast | | broadcast |
| 1 | chlorothanlonil | Bravo | 1 pt/A | | | | | | broadcast | |
| 2 | Oxamyl | Vydate C-LV | 2.1 pts/acre | | | X | chemigate | chemigate | chemigate | chemigate |
| 2 | fludioxonil | Maxim 4FS | 0.08 oz/100 lbs seed | | X | | | | | |
| 2 | azoxystrobin | Quadris | 0.8 fl. oz/1000 ft | | | X | | | | |
| 2 | fluopyram + pyrimethanil | Luna Tranquility | 11.2 fl. oz/A | | | | | broadcast | | broadcast |
| 2 | chlorothanlonil | Bravo | 1 pt/A | | | | | | broadcast | |
| 3 | Oxamyl | Vydate C-LV | 2.1 pts/acre | | | X | chemigate | | | chemigate |
| 3 | spirotetramat | Movento | 5.0 fl. oz/A | | | | | broadcast | broadcast | |
| 3 | fludioxonil | Maxim 4FS | 0.08 oz/100 lbs seed | | X | | | | | |
| 3 | azoxystrobin | Quadris | 0.8 fl. oz/1000 ft | | | X | | | | |
| 3 | fluopyram + pyrimethanil | Luna Tranquility | 11.2 fl. oz/A | | | | | broadcast | | broadcast |
| 3 | chlorothanlonil | Bravo | 1 pt/A | | | | | | broadcast | |
| 4 | spirotetramat | Movento | 5.0 fl. oz/A | | | | | broadcast | broadcast | |
| 4 | fludioxonil | Maxim 4FS | 0.08 oz/100 lbs seed | | X | | | | | |
| 4 | azoxystrobin | Quadris | 0.8 fl. oz/1000 ft | | | X | | | | |
| 4 | fluopyram + pyrimethanil | Luna Tranquility | 11.2 fl. oz/A | | | | | broadcast | | broadcast |
| 4 | chlorothanlonil | Bravo | 1 pt/A | | | | | | broadcast | |
| 5 | MCW-2 | Nimitz | 7.2 pt/A | roto-till | | | | | | |
| 5 | MCW-2 | Nimitz 480 EC | 1.8 pt/A | | | | chemigate | chemigate | chemigate | chemigate |
| 5 | fludioxonil | Maxim 4FS | 0.08 oz/100 lbs seed | | X | | | | | |
| 5 | azoxystrobin | Quadris | 0.8 fl. oz/1000 ft | | | X | | | | |
| 5 | fluopyram + pyrimethanil | Luna Tranquility | 11.2 fl. oz/A | | | | | broadcast | | broadcast |
| 5 | chlorothanlonil | Bravo | 1 pt/A | | | | | | broadcast | |
| 6 | *Paecilomyces lilacinus* | MeloCon WG | 4 lbs/A | | | X | chemigate | | | chemigate |
| 6 | fludioxonil | Maxim 4FS | 0.08 oz/100 lbs seed | | X | | | | | |
| 6 | fluopyram + pyrimethanil | Luna Tranquility | 11.2 fl. oz/A | | | | | broadcast | | broadcast |
| 6 | chlorothanlonil | Bravo | 1 pt/A | | | | | | broadcast | |
| 7 | VBC-90017 | (unregistered) | 3.0 gallon/acre | | | X | | | | |
| 7 | fludioxonil | Maxim 4FS | 0.08 oz/100 lbs seed | | X | | | | | |
| 7 | azoxystrobin | Quadris | 0.8 fl. oz/1000 ft | | | X | | | | |
| 7 | fluopyram + pyrimethanil | Luna Tranquility | 11.2 fl. oz/A | | | | | broadcast | | broadcast |
| 7 | chlorothanlonil | Bravo | 1 pt/A | | | | | | broadcast | |

Location: IREC, Tulelake, CA
Soil type: Tulebasin mucky silty clay loam with 4.5% organic matter
Potato Seed spacing: 10 inches
Vine Kill Method: Rolling and Reglone
Planting Dates: 2014 & 2015- May 27th

Irrigation: Solid-set sprinklers
Plot size: 2 rows (6ft) by 20 ft long
Herbicides: Prowl, Outlook, and Matrix
Fertilizer: 200 lbs N/A; P, K, and S applied according to soil test
Harvest Dates: 2014- October 7th; 2015- September 29th

**Methods**:
In 2014 and 2015, the study was a split-plot design with five replications. Whole plot treatments included two potato varieties: Russet Norkotah, a variety susceptible to early-dying and Gemstar Russet, a variety relatively resistant to early-dying. Sub-plot treatments included nematicide treatments and a fungicide only control. Nematicide rates and application times were based on top-performing treatments from previous research or manufacturer recommendations. Data collected included pre-treatment and post-treatment nematode counts, foliar early dying severity ratings, tuber yield, tuber size, and tuber grade. Potato stems from select treatments were collected at the first sign of early-dying in 2014 and then sent to Jeremiah Dung, Oregon State University Plant Pathologist, for stem crushing to quantify colonies of *Verticillium dahliae* in the lower stems. Plots were irrigated and fertilized according to recommended practices. Herbicides were used to control weeds. All treatments including the nematicide-free control included a full-season fungicide program for suppression of soil-borne and foliar diseases. Pre-plant and harvest soil samples were analyzed by Becky Westerdahl's lab, UC Davis Nematologist, to determine nematode counts in the soil. Special thanks to Becky and her lab staff for analyzing the soil samples.

**Results:**
Yield data from 2014 and 2015 were combined for analysis as there was not a year by treatment interaction for measured variables. Averaged across nematicide treatments, Russet Norkotah and Gemstar Russet had similar total yield (Table 2). The potato varieties differed with regard to US #1 yield, culls and 2's yield, average tuber size, foliar early-dying severity, and *Verticillium dahliae* levels in the lower stems tested in 2014. Table 2 summarizes differences between varieties averaged across nematicide treatments.

**Table 2. Differences between Russet Norkotah (high susceptibility to early-dying) and Gemstar Russet (low susceptibility to early-dying) averaged across nematicide treatments.**

| Variety | Total Yield cwt/A | US #1 Yield cwt/A | Cull & 2s Yield cwt/A | Average tuber size ounces | Early-dying severity AUDPC | Vert. Wilt in lower stems colonies/100ul |
|---|---|---|---|---|---|---|
| **R. Norkotah** | 627 | 419 | 115 | 7.65 | 191 | 77.79 |
| **Gemstar R.** | 619 | 469 | 52 | 9.17 | 59 | 2.25 |
| **P-value** | .71 | .011 | .04 | .002 | <.001 | <.001 |

Variety data was combined for analysis when comparing nematicide treatments as there was no interaction between varieties and nematicide treatments. Total yield, US #1 yield, cull yield, average tuber size, tubers per plant, and nematode counts were similar across nematicide treatments including the untreated control (Table 3).

The reason nematicide treatments did not influence potato yields, early dying severity, and nematode populations both years is puzzling. One explanation is Luna Tranquility fungicide was used to control early blight and white mold in all treatments both years. Recent research has shown Luna Tranquility also kills nematodes. When the research team selected Luna

Tranquility it was unknown the active ingredient, fluopyram, had nematicide activity. Another possible explanation is *Pratylenchus neglectus* at the levels tested in 2014-2015 did not reduce potato growth and development. Previous research with *Pratylenchus neglectus* is mixed regarding its' influence on potato yields. Pre-treatment *Pratylenchus neglectus* nematode counts from 2-12 inch soil samples collected at potato planting averaged 12 nematodes per 0.1 liters of soil in 2014 and 34 nematodes per 0.1 liters of soil in 2015. Nematode soil counts did not differ between treatments at the time of potato planting both years. Nematode counts at potato harvest averaged 5.3 nematodes per 0.1 liters of soil in 2014. In 2015, harvest soil samples were not analyzed for nematodes.

**Table 3. Influence of treatments on potato yield, potato early-dying, potato vigor, and nematode counts at harvest.**

| **Trt** # | **Treatment** | **Total yield** cwt/A | **US #1 yield** cwt/A | **Average tuber size** ounces | **Tubers per plant** # | **Cull & 2s yield** cwt/A | **Early-dying severity** AUDPC | **Early season Plant vigor** 1-10 | **14 Lesion nematode count at harvest** #/50 ml |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Fungicide Control | 631 | 461 | 8.75 | 6.72 | 77 | 124 | 7.6 | 5.8 |
| 2 | Vydate Program | 649 | 458 | 8.57 | 7.11 | 92 | 120 | 7.7 | 5.0 |
| 3 | Vydate + Movento Prog. | 623 | 431 | 8.50 | 6.86 | 90 | 126 | 7.4 | 5.3 |
| 4 | Movento Program | 610 | 432 | 8.28 | 6.79 | 84 | 124 | 7.6 | 7.0 |
| 5 | Nimitz Program | 622 | 448 | 8.18 | 7.21 | 80 | 128 | 7.6 | 4.5 |
| 6 | MeloCon Program | 608 | 435 | 8.29 | 6.85 | 82 | 126 | 7.7 | 4.5 |
| 7 | VBC-90017 Program | 618 | 442 | 8.27 | 6.89 | 78 | 126 | 7.6 | 4.3 |
| | P-Value | .101 | .239 | .499 | .407 | .284 | .590 | .41 | .29 |