Potato Progress

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Andrew Jensen, Editor. Submit articles and comments to: ajensen@potatoes.com
108 Interlake Rd., Moses Lake, WA 98837; Fax: 509-765-4853; Phone: 509-765-8845.

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Managing Verticillium Wilt of Potato Using Soil Fumigation

Dennis Johnson, Washington State University and Philip Hamm, Oregon State University

Verticillium wilt – The soil-borne fungus that causes Verticillium wilt (a.k.a. early dying) , *Verticillium dahliae*, has long-term survival structures called microsclerotia that persist in the soil. Because of these fungal structures, management generally focuses on crop rotation, growing resistant potato cultivars, and soil fumigation. While long term crop rotations may be successful, rotations of 3- 4 years generally practiced in the Columbia Basin usually do not effectively reduce levels of the fungus in soil. Growing Verticillium wilt-resistant cultivars reduces severity of early dying but must be coupled with soil fumigation when soil inoculum levels are moderate to high. Levels of 3-14 fungal propagules/g of soil have been reported to be enough to justify metam sodium use when growing Russet Burbank in the Columbia Basin. Moderately resistant cultivars return fewer microsclerotia to the soil for less infection of following potato crops than moderately to very susceptible cultivars. Cultivars Goldrush, Ranger Russet, and Umatilla Russet are moderately resistant; Russet Burbank is moderately susceptible; Shepody and Yukon Gold are susceptible; and Russet Norkotah is very susceptible. Data suggest that even when growing Ranger Russet, particularly as a full season crop, that fumigation increases yield substantially – enough to off-set the cost of fumigation.

Fumigants and application methods – Application of soil fumigants is an effective tactic for managing Verticillium wilt. Several soil fumigants have been widely used to manage Verticillium wilt of potato including metam sodium, metam potassium, and chloropicrin. Most common is metam sodium, which has been widely and successfully applied through sprinkler irrigation systems (chemigation) and is most effective in areas with coarse-textured soils. Metam sodium can also be applied by shanking into the soil profile. Metam sodium is often applied in combination with 1, 3-dichloropropene (1, 3-D). Another product that will control Verticillium wilt is chloropicrin. A relatively new product is a water-based solution of chloropicrin with 1, 3-D. Either chloropicrin product is shank-applied and like the combination use of metam sodium and 1,3 D, the combination of chloropicrin and 1,3 D is very effective in reducing both soil borne fungi and nematodes. Depending upon the chemical, rate, and soil environmental conditions at time of application, fumigation has reduced soil populations of *V. dahliae* by 85-95% with a corresponding suppression of potato early dying. Metam potassium is also available, but like chloropicrin + 1,3 D, this product has been more expensive than the alternatives and hence has not widely been used.

When applied by chemigation, the amount of irrigation water generally dictates the depth of fumigant penetration into the soil. When shank-applied, metam sodium and metam potassium are injected into the soil profile with limited amounts of water at one or more depths. The shank application method requires sealing the soil surface to reduce product escape from the "chimney" produced by the shanks as they move through the soil. To reduce the risk of volatilization and drift and assure maximum fumigant activity against *Verticillium* spores, **soil fumigants should not be applied by chemigation during windy periods, air inversions, or at high ambient air temperatures.** Regardless of the application method, minimum soil temperature and moisture requirements identified on the label must be met for proper and effective application.

The fumigant 1,3-D is primarily used to control soil-borne nematodes and should not be used alone if there is a risk of Verticillium wilt. This material is always applied by shank, usually to a depth of 18-24 inches. Do not apply 1,3,D unless the previous crop residue has been incorporated and soil temperature and moisture requirements are met. Soil sealing is also required. A common treatment in some potato producing areas is the application of both metam sodium and 1,3 D, at reduced rates (generally 30 GPA and 15 GPA, respectively) of both products. When both are used, 1,3-D is always applied first, followed not less than 1 week later by a metam sodium application. These lower rates of both products in this sequential combination can be used without lowering efficacy. This combination treatment is very effective at reducing Verticillium wilt and infection by nematodes.

Soil preparation – Fumigation is usually done after tillage because good soil preparation, along with proper application procedures, is important in achieving the desired results. Before a soil-injected fumigant is applied, the soil should be in good seedbed condition. It is important that clods and compaction layers are broken up and crop residues are finely chopped and thoroughly incorporated. If this is not done, target organisms in soil clods and large pieces of plant debris may survive because they are not exposed to the fumigant. Plant debris that is not well incorporated also allows the fumigant to escape from the soil before the target pests are exposed for the duration needed to achieve the desired results.

Soil sealing – The best results are obtained when the soil is moist and 50-70˚ F at a 6-inch depth. Chloropicrin used alone is highly volatile – when applied the soil must be covered with tarps to prevent premature escape of the gas. The combination product of 1,3 D and chloropicrin does not require tarping, but the soil should be sealed after application. The fumigants 1,3-D and metam sodium or metam potassium are less volatile, and the soil may be sealed with a cultipacker or a similar implement after treatment. Fumigants can damage plants, but they dissipate from the soil in about 2 weeks (1,3-D). Dissipation occurs more quickly under warm and dry conditions.

Soil moisture – Soil moisture has a direct influence on the movement of fumigants through soil. Too much and too little soil moisture inhibit movement of the gas in the soil. Low soil moisture can also allow the chemical to escape the soil too rapidly. Proper soil moisture for at least a period of time prior to fumigation generally provides better control of fungal spores and weed seeds. The soil should barely retain its shape when squeezed in the palm of the hand (65-75% available soil moisture).

Depth and width of shank application - Most soil-borne plant pathogenic fungi reside in the upper 12 inches of the soil profile. Concentrating fumigants in this area is likely be the most beneficial. Fumigants diffuse upward more readily than downward and the fumigant must be placed below the midpoint of the zone to be treated. For example, in a 12-inch treatment the fumigant is usually applied at an 8-10 inch depth. The effective lateral range of chloropicrin is about 6 inches from the point of injection so that 12 inches is the maximum spacing for chloropicrin injections to ensure that the killing zones are in contact. This is an important consideration when working ground following application. Do not work soil deeper than the fumigant was applied to prevent bringing up soil from untreated areas.

Time of application - Early fall application of soil fumigants is usually better than early spring application. In the spring it is difficult to obtain the proper soil temperature long enough before planting to ensure good fumigation. When spring application is followed by a period of cold weather, the waiting period prior to planting must be extended to prevent phytotoxicity. This is especially true with a less volatile fumigant such as 1,3-D. Phytotoxicity can be prevented by additional working the soil after the exposure period and before planting.

Other considerations – Soil fumigation is not a cure-all. It can reduce populations of soil borne pathogens, nematodes and insect pests, but these organisms are not completely eradicated. Following fumigation, populations of pathogens, nematodes, and insects are likely to increase again to damaging levels, possibly after only one season of growing a susceptible crop.

Despite the success of soil fumigation, some production sites have experienced inconsistent performance of metam sodium, which may be due to improper soil temperatures, moisture, or application but also may be due to enhanced biodegradation of this chemical. Enhanced biodegradation is an accelerated decay of pesticides in soil through microbial activity. Populations of soil microbes that break down MITC, the active ingredient of metam sodium, have increased dramatically in some situations when metam sodium has been applied annually for several years. Because most potato soils in the Columbia Basin are fumigated no more than every 3-4 years, biodegradation of metam sodium is probably not a major consideration. Nevertheless, it is prudent to be aware of the potential for reduced efficacy associated with frequent fumigation with this chemical.

Fumigation Season

We all know that Washington potato growers are the best in the country, producing large yields of high quality potatoes through careful stewardship. It is especially important this fall to maintain the industry's good management practices when it comes to soil fumigation. In recent years, EPA and various interest groups across the country are carefully scrutinizing off-gassing of soil fumigants such as metam sodium. Our industry should do everything possible to prevent off-site movement during chemical applications this fall. A pungent odor that is very irritating to the eyes and mucous membranes during or after application is a signal that the biologically active ingredient (MITC: methyl isothiocyanate) is escaping (MITC is the biologically active agent responsible for controlling soil-borne nematodes and diseases).

Metam rapidly converts to gaseous MITC on contact with moist soil. Because of its vapor pressure, MITC can readily escape into the atmosphere unless proper mitigation measures are used to minimize surface emissions. Any product loss will reduce the control effectiveness, but will also contribute to off-site movement of MITC.

For soil injection, the soil within the treatment zone should be moist – between 50 and 85 percent of field capacity – and the soil surface should be level and also free of residue and clods to help ensure soil surface sealing by the roller or packer at time of application. The soil profile within the treatment zone should be sufficiently loosened to allow for gas diffusion, thereby increasing contact with soil-borne pests.

For chemigation, field preparation is the same as for soil injection. To facilitate movement into the soil profile, metam should be applied with 0.75- to 1.0-inch of water. But in no case should application rate exceed the soil infiltration rate, which may result in surface runoff. An irrigation system may require a retrofit with different nozzle package to achieve the recommended water application rate.

Chemigation must not occur when air temperature is 90° F or higher or when wind speed will result in off-site movement. Wind velocity (in conjunction with release height) and droplet size are the two most influential factors affecting drift. Temperature and relative humidity influence the evaporation rates of droplets. Since evaporation of liquid from a droplet decreases its mass, it also influences the drift distance of the droplet. System pressure and the nozzle package significantly impact droplet size, which then is highly impacted by temperature, wind, and relative humidity. Concerning drift distances, the influence of these factors on smaller droplets (200 microns diameter and less) is much greater than on larger droplets. (The diameter of a human hair is roughly 75 to 100 microns; a paperclip wire is 850 microns.) Since larger spray droplets are less susceptible to drift and are more likely to reach the soil surface, management practices should be undertaken to increase droplet size, primarily, and to decrease release height. Remember: by reducing a droplet's size in half, eight times the number of droplets are created.

When a metam product is applied by chemigation, the following stewardship practices are recommended: disable the end gun; only apply through low pressure irrigation systems fitted with drop tubes; extend drop tubes to within 18 to 24 inches of the soil surface, if possible; do not apply during inversions; air temperature should not exceed 85° F; monitor the application constantly when operating close to sensitive areas; and consider soil injection on fields located near residential, business, or industrial areas.

WSPC Research Review Schedule

This year the potato commission is launching a new research review process with the aim to build a strong sense of collaboration between industry and the research community. For more information, please contact Andy Jensen at the commission office or see the website at [www.potatoes.com/research.cfm.](www.potatoes.com/research.cfm)

Mustard Green Manure Field Days

North Columbia Basin
Wednesday, Oct. 25th, 2006
10 am at the Dale Gies Farm
1.5 mi. West of Rd. M on Rd. 5 SE
Moses Lake, Washington

South Columbia Basin
Thursday, Oct. 26th, 2006
10 am at Glen Roundy Farm
0.5 mi. E of Douglas Fruit (Taylor Flats Rd) on Clark Rd.
Pasco, Washington

- **The Benefits of mustard green manures**
- **Management of mustard green manures**
- **Research results on green manures in combination with fumigants for nematodes**
- **Economics of green manures before potatoes**
- **New *Brassica* green manures**

For More Information Call Andy McGuire
Center for Sustaining Agriculture and Natural Resources
WSU Cooperative Extension, Grant-Adams Area
509-754-2011 ext. 413, amcguire@wsu.edu

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Washington Potato Acreage, Production, and Storage Data

Crop Year	Harvested Acreage	Yield Per Harvested Acre (cwt)	Tons/A	Production (000cwt)	Stocks on Hand (000 cwt) Dec. 1	Jan. 1	Feb. 1	Mar. 1	Apr. 1	May 1	June 1
1966	58,000	376	18.8	21,830	18,300	7,150	5,500	3,950			
1967	64,000	345	17.3	22,090	10,660	8,800	6,600	4,400			
1968	64,000	378	18.9	24,173	10,430	8,800	7,050	5,100			
1969	71,700	415	20.8	29,796	15,300	13,100	10,300	7,800			
1970	87,000	386	19.3	33,590	18,500	16,000	12,500	9,700			
1971	78,000	386	19.3	30,110	16,450	13,500	10,350	7,500			
1972	75,000	418	20.9	31,365	15,800	13,400	10,300	7,100	4,200		
1973	82,000	430	21.5	35,260	18,600	15,600	12,600	9,100	5,500		
1974	98,000	420	21.0	41,160	22,500	20,500	16,800	12,800	8,900		
1975	105,000	460	23.0	48,300	27,900	24,100	19,900	11,500	10,000		
1976	124,000	450	22.5	55,800	33,200	29,700	25,000	20,100	15,200		
1977	110,000	460	23.0	50,600	28,400	24,700	20,800	15,900	11,300		
1978	109,000	465	23.3	50,685	32,000	28,800	24,000	19,300	14,500	9,500	
1979	103,000	475	23.8	48,450	30,800	27,300	23,300	19,000	14,400	10,500	
1980	87,000	505	25.3	43,935	24,300	22,000	18,500	14,600	10,900	7,200	
1981	108,000	490	24.5	52,920	29,200	25,100	21,000	17,000	12,600	8,200	
1982	110,000	480	24.0	52,800	29,200	25,100	21,600	17,100	13,200	8,600	
1983	103,000	520	26.0	53,560	29,500	25,600	21,800	16,500	11,000	7,100	
1984	115,000	495	24.8	56,925	29,600	25,900	20,800	16,600	11,300	7,000	
1985	127,000	505	24.3	61,100	33,500	30,000	25,700	21,000	16,200	9,700	
1986	118,000	510	25.5	60,200	32,300	28,000	24,400	20,400	14,600	8,700	
1987	124,000	540	27.0	67,000	36,600	32,900	28,300	22,800	17,500	12,400	
1988	115,000	550	27.5	63,300	36,700	32,100	27,700	22,500	16,200	10,700	
1989	118,000	545	27.3	64,310	34,500	30,400	25,100	20,000	13,100	7,100	
1990	132,000	515	25.8	67,980	35,500	29,500	24,500	19,800	15,100	10,400	
1991	141,000	535	26.8	75,440	37,000	32,200	27,000	21,200	15,000	9,600	
1992	125,000	525	26.3	69,300	31,000	26,700	24,900	19,800	13,000	8,200	
1993	150,000	590	29.5	88,500	43,500	38,500	32,000	26,500	20,000	13,500	
1994	152,000	585	29.3	88,900	47,500	43,000	37,500	30,500	23,500	17,000	
1995	147,000	550	27.5	80,850	39,500	33,000	30,500	25,000	18,000	12,500	
1996	161,000	590	29.5	94,990	48,000	42,000	36,500	30,000	23,000	16,500	
1997	152,000	580	29.0	88,060	47,000	41,500	36,500	29,500	22,500	16,000	
1998	165,000	565	28.3	93,225	49,000	43,500	36,500	29,500	21,500	14,500	7,500
1999	170,000	560	28.0	95,200	48,000	41,000	35,000	28,000	20,500	14,500	7,000
2000	175,000	600	30.0	105,000	59,000	52,000	44,500	37,500	29,500	21,500	13,000
2001	160,000	590	29.5	94,400	53,000	45,500	40,000	32,500	25,000	18,000	10,000
2002	165,000	560	28.0	92,400	53,000	46,500	40,000	33,000	25,500	19,500	12,000
2003	162,000	575	28.8	93,150	51,000	44,000	38,000	29,500	21,500	15,000	7,000
2004	159,000	590	29.5	93,810	50,000	43,000	36,500	29,000	22,000	15,500	8,000
2005	154,000	620	31.0	95,480	52,000	46,000	40,000	32,000	24,500	17,000	9,000
2006	156,000	**Any predictions??**									

Data from National Agricultural Statistics Service