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Verticillium Wilt Of Potato In Southeastern Idaho

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Verticillium wilt of potato may be caused by either of two soilborne fungal species —*Verticillium dahlae* (microsclerotial form) or *Verticillium albo-atrum* (dark mycelial form). In Idaho and other arid, growing regions of the West, this disease is caused by *V. dahliae*. The most commonly associated *V. dahliae* strain is similar in type to the nondefoliating strain (SS4) found in cotton. In Idaho potato fields, the "severe" defoliating strain (T-1) associated with cotton has not been recovered.

The host range of *V. dahliae* is broad. The fungus infects many dicotyledonous plants, including numerous weed species. Recent studies suggest that even plants native to the Idaho desert (salt bush, rabbit brush, salt sage and fringed sagebrush) may serve as host plants for perpetuation of the fungus.

Initial symptoms of the disease in potato are a slight downward growth of petioles and yellowing of lower leaves. Leaf yellowing proceeds up the stem (often in a one-sided manner), with the upper leaves the last to show symptoms. Leaf yellowing is then followed by wilt, browning, necrosis, flagging and eventual death of the stem (Fig. 1). Discoloration of conducting tissue is commonly associated with *V. dahliae* at the end of the season. Stem-end discoloration in tubers may also occur in severe cases — a symptom sometimes confused with net necrosis caused by the leafroll virus.

Depending on severity, time of occurrence and growing season, potato yields and tuber size may be substantially reduced. Yield losses of 50 to 100 cwt per acre are not uncommon. Losses of up to 30 percent have been documented in southeastern Idaho.

Verticillium dahliae survives in the soil from year to year as several types of resting structures including small, compact, fungal masses called microsclerotia. These structures serve to protect the fungus under adverse conditions (e.g., drought, cold, etc.). In the spring, they germinate and invade

roots mostly by direct penetration. The fungus then colonizes the plants, starting from the roots and extending to the top of the plant and even into the leaves.

After several successive potato crops, the level of soilborne inoculum may be high. This inoculum is long lasting in soil. With grain rotations, the minimum period required to reduce inoculum effectively in moderately to heavily infested land requires approximately 5 to 10 years. In "old" potato ground, the short rotation practices that are commonly followed in Idaho (2 to 3 years) are ineffective in reducing the pathogen. Potato seed may also provide a source of inoculum, but seed-borne inoculum is probably most important on "new" potato ground. As with certain other potato pathogens (*Rhizoctonia solani, Erwinia carto-vora, E. carotovora* f. *atroseptica, Colletotrichum atramentarium* and *Fusarium* spp.), seed lots may vary greatly as "carriers" of inoculum.

Association with Other Pathogens

Although direct evidence is largely lacking, in-direct evidence suggests interactions between nematodes and Verticillium wilt of potato. The root lesion nematode (*Pratylenchus* sp.) and root knot nematode (*Meloidogyne* sp.) are the two nematode groups most commonly associated with Verticillium wilt of potato, but there may be others. Field studies with certain fungi (e.g., *Rhizoctonia solani* and *Collectotrichum atramentarium*) have failed to indicate interactions with Verticillium wilt.

Control and Disease Suppression

Sanitation

To delay inoculum buildup, use of Verticillium-free seed and vine burning are particularly important on "new" potato ground. Table 1 shows recovery of the pathogen among different growers from several seed-growing regions. The data show variation in the presence of the fungus in different seed lots.

Potato stems provide the primary source of soil-borne inoculum. Where local laws permit, stem burning is recommended. This practice's effectiveness depends upon complete burning of stems.

Table 1. Association of *Verticillium dahliae* with Idaho certified potato seed of Russet Burbank.

Source of seed by seed growing area	No. of grower lots[1] indicating *V. dahliae* association with tuber peelings	*V. dahliae* prop/gm of air-dried tuber peelings (range)
1	0/10[2]	0
2	3/7	20-520
3	0/8	0
4	1/3	0-140
5	0/3	0
6	0/1	0

[1]Tubers were washed before peeling, and the sample size consisted of stem-end peelings from 18 to 25 tubers per lot.

[2]Number of grower lots associated with *V. dahliae*
Total number of grower lots examined

Resistance

The Russet Burbank variety has a moderate degree of field resistance to *V. dahliae*. Of the potato varieties grown in Idaho, however, Targhee is the most resistant.

Cultural Management

In potato fields that have been cropped for several years, the first line of defense against Verticillium wilt in Russet Burbank potatoes is optimum irrigation and soil fertility. By favoring this variety, resistance to *V. dahliae* is also favored. You can get recommendations for irrigation, fertility and cultural practices from the U of I and your Extension county office.

Studies in Bingham County over several years showed that cultural management practices can have a major effect on suppressing the disease's severity. Factors related to inadequate irrigation, method of irrigation and low levels of N, P and K have been closely associated with the disease.

Moisture Stress

Moisture stress increases the disease's severity. As the season progresses (particularly beyond the "flowering stage"), the influence of moisture stress on Verticillium wilt may become pronounced (Table 2).

Table 2. Effect of moisture stress on Verticillium wilt in Russet Burbank potato.[1]

Irrigation treatment	% stems with wilt[2] Aug. 29
No wilting point (WP)[3]	6.5 AB[5]
WP June 26-30[4]	1.5 A
WP July 21-25[4]	22.5 BC
WP Aug. 15-19[4]	43.5 C

[1]Wilt was related to presence of *V. dahliae* in stems.

[2]Percentage of stems showing symptoms typical of severe *V. dahliae* wilt (severe wilt = >75% of stem with severe wilt symptoms).

[3]Plots were maintained between 60 to 100% available soil moisture throughout season. Sprinkler irrigated.

[4]On dates indicated moisture was depleted to wilting point.

[5]Different letters denote differences to 95% probability level, and no differences between treatments with same letters.

Furrow Irrigation vs. Sprinkler Irrigation

Verticillium wilt is usually more severe when furrow rather than sprinkler irrigation is used. The difference may be that sprinkler irrigation makes more N available to the plants. With furrow irrigation, N accumulates within the upper 3 to 6 inches of the soil profile. N is more uniformly distributed throughout the soil with sprinkler irrigation. When N is less available to the plants' root systems because of leaching and poor distribution, the disease becomes more severe.

Nitrogen Availability

The Russet Burbank plant is more disease tolerant when N is present at an optimal level for plant growth. The U of I has fertility recommendations for your specific growing area.

In the Egin Bench area, nitrogen availability has been shown to be one of the most important factors associated with disease severity. Petiole N levels early in the season (July 5) have demonstrated a high correlation with wilt severity and with the degree of the pathogen's colonization in potato stems. The wilt's severity was related to the degree of *V. dahliae* colonization in potato stems and was associated with low yields and undersized potatoes.

At Egin Bench, the use of anhydrous ammonia (NH_3) was shown to reduce the disease. When compared with several commonly used granular fertilizers in a subirrigated field, treatment with NH_3 provided a significant increase of petiole N level. The normal mode of NH_3 application (involving a deeper incorporation depth than granular-applied fertilizers) probably resulted in better N distribution throughout the soil profile. It is doubtful that this same relationship would result from sprinkler irrigation. Table 3 shows this relationship and the relationship between petiole N level and Verticillium wilt susceptibility.

With higher petiole N level (21,200 ppm on July 5), the disease was significantly reduced when compared to treatments that gave lower N levels (12,400 to 14,900 ppm on July 5). Where disease was reduced, total yields increased from 10 to 17.5 percent. U.S. #1 tubers increased from 17 to 22 percent.

With lower N treatments, *V. dahliae* inoculum levels were found to be closely related to wilt severity. The degree of the pathogen's colonization in stem tissue correlated with both symptom expression and petiole N levels. Treatments were found to have no direct effect on soilborne inoculum.

Chemical Control

A wide range of fumigants has shown some effectiveness in controlling Verticillium wilt in potatoes (Telone, Telone C, DD, Vapam, Vorlex, etc.). However, all fumigants are relatively high in cost and should be considered only as a last resort in southeastern Idaho. Table 4 shows the relative effectiveness of two of these products (Telone and Telone C).

Telone C but not Telone reduces the pathogen in the soil. Picfume, a component of Telone C, has

Table 4. Effects of fumigation on soilborne Verticillium populations.

Treatment	Propagules/gm[1] of air-dried soil
Untreated	18.3 A
Telone 30 gpa	17.7 A
Telone C 20 gpa	6.3 B
Telone C 30 gpa	2.0 B

[1]Assays in May 1975 at Ft. Hall several weeks after fumigation treatments.

Table 3. Influence of fertilizer treatments on Verticillium wilt and the relationship to N-availability — Egin Bench.

Nitrogen treatment[1]	ppm NO_3-N[2] from upper foot of soil	ppm NO_3-N[3] in petioles	*V. dahliae*[4] prop/gm in soil	% Verticillium wilt[5] moderate to severe	% Verticillium wilt[5] severe	*V. dahliae* prop/gm of stem tissue Aug. 10	*V. dahliae* prop/gm of stem tissue Aug. 17
NH_4NO_3	48.7[6]	14,900 x[7]	44.7[6]	51.3 x[7]	25.7 A[8]	387[6 9]	1,343[6]
Urea	30.7	12,400 x	36.7	50.0 x	18.3 A	350	1,447
NH_3 (anhydrous)	35.7	21,200 y	42.7	24.7 y	8.7 B	167	773
$(NH_4)_2SO_4$	43.0	13,300 x	38.7	53.0 x	19.0 A	260	870

[1]All fertilizer treatments applied at 150 lb N/acre.

[2]Soil samples for analysis collected June 21 (over 1 month after fertilizer application).

[3]Petioles collected July 5 approximating time of tuberization.

[4]Soil samples for *V. dahliae* assay taken June 21 (more than 1 month after fertilizer application) from upper 6 inches of soil profile.

[5]Wilt severity on Aug. 17.

[6]Differences not significant.

[7]Different letters denote differences to 99% probability level by Duncan's multiple range test.

[8]Different letters denote differences to 95% probability level by Duncan's multiple range test.

[9]*V. dahliae* propagule counts in potato stem tissue were positively correlated (95% probability level) with wilt severity and negatively correlated (95% probability level) with NO_3-N in potato petioles.

direct fungicidal properties, but Telone does not. Both products, however, have been shown to suppress significantly *V. dahliae* infections and Verticillium wilt. Generally, when applied at the same rate, treatment with Telone C is more effective than Telone for wilt suppression.

Table 5 compares several fumigation treatments over a 4-year period with resulting potato yield increases. These yield relationships were closely associated with Verticillium wilt severity (higher yields with less wilt). Treatments were effective only when applied every year.

Table 5. Effects of fumigation treatments on potato yield over 4 years when potatoes were grown continuously — Ft. Hall (1971 to 1974).

Treatment	Fumigated each year		Fumigated every other year	
	Total cwt/acre	U.S. 1's cwt/acre	Total cwt/acre	U.S. 1's cwt/acre
Untreated	271 x[1]	148 a[2]	279[3]	156[3]
Telone 30 gpa	302 xy	171 ab	288	155
Telone C 20 gpa	322 y	189 b	305	175
Telone C 30 gpa	329 y	194 b	307	182

[1]Different letters (vertically arranged) denote significant differences to 99% probability level.

[2]Different letters (vertically arranged) denote significant differences to 95% probability level.

[3]Differences not significant.

In certain field situations, Temik (aldicarb, an insecticide-nematicide) has shown suppressive effects on Verticillium wilt in potatoes. Depending on the disease's severity, Temik's use has resulted in slight but significant yield increases.

Temik's effect on Verticillium wilt appears to be indirect. Although Temik is not a fungicide, it does have nematicidal properties. Nematode populations are correlated closely with stem invasion by *V. dahliae* and with Verticillium wilt severity. Field studies have shown Temik treatment (applied at 3.0 lb/acre a.i.) at planting time reduces populations of the root lesion nematode (*Pratylenchus* sp.) by 66 percent and the spiral nematode (*Helicotylenchus* sp.) by 70 percent.

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Trade Names

Trade names are used in this publication to simplify the information presented. Use of trade names does not imply an endorsement of the product nor criticism of similar products that are not mentioned.

Chemical Recommendations

The chemical recommendations made in this publication are based on the best information available at the time of printing. Before using pesticides, read the instructions on the label and be sure you follow all precautions and restrictions for safe use of the product.

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