

## **FLUE-CURED TOBACCO DISEASE CONTROL**

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Good disease control in flue-cured tobacco results from accurate diagnosis of disease problems, careful consideration of disease severity in each field, and prudent use of disease control practices. *Consistent disease control depends on the use of several control practices together. Crop rotation, early root and stalk destruction, and resistant varieties should always be used in conjunction with disease control chemicals.*

**ACCURATE DIAGNOSES OF DISEASE PROBLEMS** is the first step in controlling flue-cured tobacco diseases. Note any signs of disease during the growing season. Plant and soil samples can be taken and analyzed to identify the cause of the problem. Don't forget to record what the problem was determined to be, where and when it occurred, and how bad it eventually became, so that you can plan appropriate control practices for the future.

**DISEASE-RESISTANT VARIETIES** may be the most cost-effective way to control disease. Flue-cured tobacco varieties are available to Virginia growers with resistance to black shank, Granville wilt, mosaic, as well as cyst and root-knot nematodes.

**CROP ROTATION** is particularly effective in helping to control black shank, Granville wilt, most nematodes, and tobacco mosaic. Crop rotation also provides many agronomic benefits. Length of rotation (the longer the better) and types of alternate crops are among the most important rotation considerations. Table 1 lists some possible rotation crops.

**EARLY DESTRUCTION OF ROOTS AND STALKS** reduces overwintering populations of nematodes and disease-causing organisms by destroying the tobacco debris that pathogens rely on for food and shelter during the fall and winter. *The earlier and more complete the destruction of tobacco debris, the better the disease control.* The objective of early root and stalk destruction is to pull the roots out of the ground, dry them out, break them up, and rot them away as soon as possible. Table 2 lists the steps involved.

**Table 1. Usefulness of various rotation crops for tobacco disease control<sup>1</sup>.**

<b>Rotation Crop</b>	<b>Nematodes</b>					<b>Tobacco Mosaic Virus</b>	<b>Black Root Rot</b>
	<b>Black Shank</b>	<b>Granville Wilt</b>	<b>Root-Knot</b>	<b>Tobacco Cyst</b>			
Fescue	H	H	H	H	H	H	
Small grain	H	H	H	H	H	H	
Lespedeza 'Rowan'	H	H	H	-	H	L	
Soybean	H	H	L <sup>3</sup>	H	H	L	
Corn	H	M	L	H	H	H	
Sweet potato	H	M	L <sup>4</sup>	-	H	H	
Cotton	H	M	N	-	H	L	
Milo	H	M	L	H	H	H	
Peanuts	H	L	N	H	H	L	
Pepper	H	N	N <sup>2</sup>	L	N	H	
Potato, Irish	H	N	L	L	H	H	
Tomato	H	N	N <sup>3</sup>	N	N	M	

<sup>1</sup>Adapted from Flue-Cured Tobacco Information, North Carolina Cooperative Extension Service. Ratings indicate the value of each rotation crop for reducing damage caused by each disease in the subsequent tobacco crop, and assume excellent weed control in each rotation crop; H = highly valuable, M = moderately valuable, L = Little value, N = no value – may be worse than continuous tobacco, - = unknown.

<sup>2</sup>May be highly valuable for some species or races of root-knot nematodes

<sup>3</sup>However, root-knot resistant cultivars can be highly effective rotation crops for tobacco.

<sup>4</sup>Root-knot resistant sweet potato cultivars are moderately effective rotation crops for tobacco.

**Table 2. Steps in early stalk and root destruction.**

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1. Cut stalks into small pieces with a bush-hog or similar equipment *immediately after final harvest*.
  2. Plow or disc-out stubble the same day that stalks are cut, pulling roots completely out of the soil.
  3. Re-disc the field *2 weeks after the first operation*.
  4. Plant a cover crop when root systems are completely dried-out and dead.
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### DISEASE CONTROL IN TOBACCO GREENHOUSES

Avoid seeding tobacco greenhouses any earlier than necessary. Eliminate any volunteer tobacco plants. Plants closely related to tobacco (tomatoes,

peppers, etc.) should not be grown in greenhouses used for transplant production.

Disease-causing organisms can enter a greenhouse in soil or plant debris, so entrances should be covered with asphalt, concrete, gravel, or rock dust. Footwear should be cleaned or disinfected before entering a greenhouse. Float bays should be re-lined with fresh plastic each year and should be free of soil and plant debris.

If tobacco mosaic (TMV) may have occurred in the previous year, greenhouse surfaces such as side-curtains, center walkways, and the 2x6 boards that support the float bays should be disinfected. A 10% solution of household bleach in water is sufficient for these purposes, as are most disinfectants. There is no need to spray the purline supports or the plastic covers over the greenhouse. Float trays used when TMV may have been present should be washed and cleaned thoroughly before being fumigated. Mosaic has a number of weed hosts (horsenettle, ground cherry) which should be removed from the vicinity of tobacco greenhouses.

Float trays should be cleaned and disinfected to minimize diseases that reduce seed emergence and kill or damage seedlings (caused by *Rhizoctonia* and *Pythium*). Methyl bromide is no longer available for purchase, but if already on-hand, may be used as in the past. Dry trays should be loosely stacked no more than 5 ft high and completely enclosed in plastic. Use one pound of methyl bromide per 330 cubic feet (400 trays). Trays should be fumigated 24 to 48 hours, then aerated for at least 48 hours before use. Be sure to read the label for space fumigation and follow it exactly. Aerated steam (maintained at 160°F to 175°F for at least 30 minutes) can also be used to minimize damping-off and sore shin diseases.

Don't fill float bays with water from streams or ponds, as water from these sources may be contaminated. Avoid introducing disinfestants into water intended for plant uptake. Moving water from one bay to another can increase spread of water-borne pathogens. Filling bays with water long before floating the trays can make *Pythium* disease problems worse.

Condensation in the greenhouse favors disease. Temporarily lowering the side-curtains near dusk and ventilating the greenhouse with horizontal airflow fans will help reduce condensation. Minimize overhead watering and potential splashing of media from one tray cell to another. Correcting drainage problems in and around the greenhouse will also help avoid excess humidity.

To avoid spreading TMV, mower blades and decks should be sanitized with a 1:1 bleach:water solution between greenhouses and after each clipping. Plant debris left on trays after clipping is one of the primary causes of collar rot problems. High vacuum mowers should be used to clip tobacco

seedlings. Clippings, unused plants, and used media should be dumped at least 100 yards from the greenhouse.

Bacterial soft rot causes a slimy, watery rot of leaves and stems and can easily be confused with damage from collar rot. Greenhouse management practices that help minimize collar rot will also help prevent bacterial soft rot. Management practices for angular leaf spot and wildfire (two other diseases caused by bacteria) can also help reduce bacterial soft rot as a side-effect.

### SPECIFIC DISEASES IMPORTANT IN VIRGINIA

Diseases like **black shank** and **Granville wilt** are caused by microscopic organisms that live in the soil. Any activity that moves soil from one place to another can spread these diseases. *Crop rotation, early root and stalk destruction, and a resistant variety should all be used before considering use of a pesticide to control black shank or Granville wilt.*

Black shank is caused by a fungus-like pathogen that lives in soil and attacks tobacco roots and stalks. Table 3 presents results from a 2016 on-farm test, and Tables 4 and 8 present black shank resistance ratings for flue-cured tobacco varieties. *Because varieties possessing the Ph<sub>p</sub> gene have been planted so often, for so long, Virginia tobacco producers should assume their fields contain race 1 of the black shank pathogen.* Growers planting black shank problem fields in 2017 should seriously consider applying a soil fungicide in addition to planting a variety with high resistance to race 1 of the black shank pathogen. Remember that while soil fumigants provide good to excellent control of Granville wilt and nematodes, they are generally not effective for black shank control.

**Granville (Bacterial) wilt** is caused by a soil-inhabiting bacterium that invades tobacco plants through one or more roots, and often kills the entire plant. The pathogen can also invade tobacco plants through wounds, so early and shallow cultivation and hand-topping can help reduce spread in infested fields. Although symptoms are somewhat similar to those for black shank, intermediate symptoms of Granville wilt involve wilting on only one side, and wilted leaves may retain their normal green color rather than yellowing. *Crop rotation and use of resistant varieties is ESSENTIAL for Granville wilt control.* Including soybeans as a rotation crop helps reduce losses to this disease (Table 1). Disease reduction and yield increases are generally much larger from use of resistant varieties compared to soil fumigation (Tables 5, 6 and 8).

**Tomato spotted wilt virus (TSWV)** is spread by various species of thrips usually within the first few weeks after transplanting. Greenhouse application of an appropriate systemic insecticide can significantly reduce damage caused by TSWV.

**Table 3. Survival of selected flue-cured tobacco varieties in a black shank-infested field in Brunswick County, VA in 2016.**

Variety	GENE	% Healthy Plants				
		7 June	7 July	8 Aug	7 Sept	22 Sept
K 346	-	100	100	100	99	99
GL 395	-	100	100	98	99	98
SP 225	+	100	100	100	99	98
NC 925	-	100	100	96	95	98
PVH 1452	+	100	99	99	98	98
CC 33	-	100	99	98	98	97
CC 143	-	100	99	94	96	96
NC 606	-	100	100	96	95	94
CC 1063	-	99	99	94	96	94
PVH 1920	-	100	97	96	95	93
GL 939	-	100	97	91	94	93
NC 299	-	100	99	83	83	80
PVH 1600	+	100	96	83	81	78
NC 196	+	100	97	76	78	74
K 730	-	99	97	77	78	70
PVH 2275	+	100	88	51	40	34

**Tobacco mosaic virus (TMV)** can be spread by contaminated clipping mowers in the greenhouse, from tobacco roots and stalks remaining in soil from previous crops, from weed hosts such as horsenettle and ground cherry, from contaminated objects and surfaces (trays, sheets, etc.), and from manufactured tobacco products. Workers should wash their hands regularly during planting. Rogueing infected plants before layby will reduce virus spread within a field. However, tobacco mosaic can't be eliminated from infested fields without crop rotation and early destruction of roots and stalks. Mosaic resistant varieties can reduce damage and may help eliminate residual virus in infested fields. *Varieties such as CC 27, CC 37, CC 67, CC 304, GL 328, NC 102, NC 297, PVH 2254, PVH 2275 or PVH 2310 may be appropriate for fields with a history of 30 to 50 percent of the plants infected with mosaic before topping. If a TMV-resistant variety is planted, the entire field should be planted to the resistant variety to avoid significant plant injury.*

**Table 4. Reactions of flue-cured tobacco varieties to Black Shank.**

Varieties with the <i>Php</i> gene <sup>1</sup> :	% Survival (Race 1) <sup>2</sup>	Disease-Yield Index <sup>3</sup>	
		Black Shank (Race 1)	No Black Shank
PVH 1452	69	68	99
NC 196	64	68	106
SP 220	64	61	95
PVH 1118	59	59	99
CC 67	60	58	97
CC 700	50	51	101
CC 37	50	50	100
GF 318	43	45	105
NC 299	43	45	103
<b>PVH 1600<sup>4</sup></b>	<b>44</b>	<b>43</b>	<b>97</b>
NC 72	34	35	104
CC 27	32	34	107
NC 297	30	31	102
NC 92	23	23	99
PVH 2275	10	9	99
 <u>Varieties without the <i>Php</i> gene<sup>1</sup></u>			
<b>NC 938<sup>4</sup></b>	<b>86</b>	<b>87</b>	<b>101</b>
CC 1063 <sup>4</sup>	83	84	101
NC 925 <sup>4</sup>	82	82	101
CC 143 <sup>4</sup>	76	79	104
K 346	82	75	93
NC 606	69	68	99
CC 33	62	63	102
GL 395 <sup>4</sup>	67	63	95
<b>PVH 2254<sup>4</sup></b>	<b>51</b>	<b>51</b>	<b>100</b>
CC 13	47	48	103
PVH 2110	43	47	108
CC 35	42	46	111
K 326	31	34	107
PVH 2310 <sup>4</sup>	31	32	104

<sup>1</sup> Varieties with the *Php* gene possess very high resistance to race 0 of the black shank pathogen. Resistance to race 0 in varieties without the *Php* gene is similar to or higher than that to race 1.

<sup>2</sup> Average % Survival near 2<sup>nd</sup> harvest without a soil fungicide. Results are averages from 10 field experiments conducted in 2010-2015 by Clemson and North Carolina State Universities as part of the Regional Flue-Cured Tobacco Variety Evaluation Program.

<sup>3</sup> Relative Yield Index = yield of each cultivar relative to the yield of all other cultivars in the experiment(s). Yield indexes for “No Black Shank” = average relative yield from the 2010-2015 Virginia OVT tests conducted at the Southern Piedmont AREC, Blackstone. Yield indexes for “Black Shank (race 1)” = the proportional survival multiplied by “No Black Shank” yield index.

<sup>4</sup> Ratings based on limited data available. **Varieties in bold are new for the 2017 growing season.**

**Blue mold and target spot** can be significant problems for tobacco producers in Virginia. The fungicide Quadris is registered for target spot control in both the greenhouse and field. Only one application is allowed in the greenhouse, but if applied shortly after the 1<sup>st</sup> clipping, this spray should provide good foliar disease control for 3 to 4 weeks or more. Target spot also often occurs in the field as topping time nears through early in the harvest period. Timely harvest of lower leaves usually reduces disease to insignificant levels by increasing air flow in fields, allowing upper leaves to dry-out. However, preventative fungicide applications can minimize leaf spots even when wet weather conditions continue over prolonged periods of time. Multiple fungicides are available for blue mold control and are listed in Tables 8 and 9 of this chapter.

**Table 5. Performance of selected flue-cured tobacco varieties in 2016 Virginia Tech on-farm tests for resistance to Granville Wilt.**

Variety	% Healthy Plants					Granville Wilt Yield Index <sup>1</sup>
	Basker-1	Alberta	Dolphin	Basker-2	Average	
CC 1063	98	96	94	85	93	93
CC 143	89	96	83	82	87	90
PVH 1920	97	90	91	78	89	89
PVH 1452	86	96	92	84	90	88
NC 196	93	91	81	64	82	86
PVH 1600	99	94	84	75	88	85
CC 37	94	94	86	63	84	82
NC 299	90	89	74	53	77	79
GL 939	96	93	81	60	82	78
NC 925	86	82	70	67	76	77
GL 395	92	77	79	67	79	76
PVH 2254	90	88	93	32	76	76
K 730	91	79	81	24	69	65
K 394	70	29	29	50	44	44

<sup>1</sup> Granville Wilt yield Index = proportion of plants surviving for each variety multiplied by the relative yield for that cultivar in the 2010-2016 Virginia OVT tests at the Southern Piedmont AREC, Blackstone.

**Table 6. Reactions of flue-cured tobacco varieties to Granville Wilt.**

Varieties with the <i>Php</i> gene <sup>1</sup> :	% Survival <sup>2</sup>	Disease-Yield Index <sup>3</sup>	
		With Granville	No Granville
CC 37	82	81	98
CC 27	76	80	106
CC 67	79	76	96
PVH 1452	74	72	98
NC 196	59	62	105
NC 297 <sup>4</sup>	58	60	104
NC 72 <sup>4</sup>	58	60	103
PVH 2275	58	58	99
NC 299	57	58	103
GF 318	56	58	104
CC 700	52	51	100
PVH 1118	45	44	99
<b>PVH 1600<sup>4</sup></b>	<b>42</b>	<b>41</b>	<b>97</b>
NC 71 <sup>4</sup>	41	44	107
 <u>Varieties without the <i>Php</i> gene<sup>1</sup></u>			
NC 606	76	75	99
CC 1063	71	71	100
K 346	73	68	93
GL 939 <sup>4</sup>	69	65	95
CC 143 <sup>4</sup>	64	67	104
CC 33	66	66	101
GL 395	63	61	96
<b>NC 938<sup>4</sup></b>	<b>60</b>	<b>61</b>	<b>101</b>
CC 13	54	56	104
<b>GL 26H<sup>4</sup></b>	<b>53</b>	<b>56</b>	<b>105</b>
PVH 2110	50	54	108
<b>PVH 2254<sup>4</sup></b>	<b>53</b>	<b>52</b>	<b>100</b>
NC 925 <sup>4</sup>	49	50	101
K 326	39	41	107
PVH 2310	39	40	103
CC 35	21	23	111

<sup>1</sup> Varieties with the *Php* gene possess very high resistance to race 0 of the black shank pathogen. Resistance to race 0 in varieties without the *Php* gene is similar to or higher than that to race 1.

<sup>2</sup> Average % Survival near 2<sup>nd</sup> harvest without soil fumigation. Results are averages from 6 field experiments conducted in 2010 and 2012-2016 by Clemson University as part of the Regional Flue-Cured Tobacco Variety Evaluation Program.

<sup>3</sup>Disease-Yield Index = yield of each cultivar relative to the yield of all other cultivars in the experiment(s). Yield indexes for “No Granville Wilt” = average relative yield from the 2010-2016 Virginia OVT tests at the Southern Piedmont AREC, Blackstone. Yield indexes for “with Granville Wilt” = yield index without black shank multiplied by average % Survival.

<sup>4</sup>Ratings based on limited data available. *Varieties in bold are new for the 2017 growing season.*

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**Tobacco Cyst (TCN), Root-Knot, and Lesion Nematodes** are microscopic worms that live in the soil and feed on tobacco roots. *Fields continuously planted with tobacco will develop significant nematode problems.* In addition to stunting tobacco and reducing yield and quality on their own, tobacco nematodes also significantly increase levels of black shank, Fusarium wilt, and Granville wilt. Destruction of tobacco roots as soon as possible after harvest is a critical first step toward reliably acceptable nematode control in the future. Nematicides should always be used in conjunction with production practices such as early root and stalk destruction, crop rotation, and planting resistant varieties.

Frequent use of varieties with the *Ph<sub>p</sub>* gene over the last 20 years has dramatically reduced TCN populations in many fields. Nematicide use should no longer be necessary for TCN control when resistant varieties have been planted in rotated fields, but may be necessary when the number of TCN juveniles and eggs exceeds 1,000 per 500 cc of soil (Table 7). *Planting a variety without the Ph<sub>p</sub> gene for 1-2 consecutive years may allow TCN to increase to damaging levels.* Field histories and nematode assay results can be used to decide if nematicide use would be prudent for the 2017 crop.

*Several species of root-knot nematodes are now common in Virginia tobacco fields and are damaging the crop in some cases.* While all flue-cured tobacco cultivars currently being grown are resistant to races 1 and 3 of the southern root-knot nematode (*Meloidogyne incognita*), the peanut root-knot nematode (*M. arenaria*), races 2 and 4 of the southern root-knot nematode, and the Javanese root-knot nematode (*M. javanica*) have become common in Virginia. *Any galling on a “root-knot resistant” cultivar indicates the presence of these other types of root-knot.* Flue-cured tobacco cultivars CC 13, CC 33, CC 35, CC 37, CC 65, and PVH 2275 claim resistance to most or all types of root-knot, and should significantly improve control of all of these root-knot nematodes (Table 8). Rotating tobacco with some other crops will also reduce root-knot nematode populations (see Table 1), but forage legumes, such as clover, are often good hosts for root-knot. Rotation intervals should be increased as long as possible. Using an effective soil nematicide may be advisable when crop rotation and resistant varieties aren’t practical and preplant root-knot populations are high (Table 11).

**Table 7. Interpreting Root-Knot Nematode infestation levels**

Risk of Crop Loss	% Roots Galled	Nematodes/500 cc of soil		Control Options
		Fall Sample	Spring Sample	
Very Low	1 to 10	1 to 200	1 to 20	Practice crop rotation and/or plant a resistant variety
Low	11 to 25	201 to 1,000	21 to 100	Use crop rotation in combination with a resistant variety and/or a nematicide
Moderate	26 to 50	1,001 to 3,000	101 to 300	Increase rotation interval. Also use a resistant variety and a nematicide rated 'G' or higher
High	Over 50	Over 3,000	Over 300	Increase rotation interval if at all possible. Use a resistant variety with a nematicide rated 'E'

Significant crop stunting and relatively high populations of lesion or meadow nematodes (*Pratylenchus* species) seem increasingly common in flue-cured tobacco fields in Virginia. However, not all lesion nematode species damage tobacco, and nematode assay results aren't currently able to differentiate those species from others that don't parasitize tobacco. Rotation crops that reduce root-knot and tobacco cyst nematodes aren't necessarily effective for lesion nematodes, although a single year of forage or grain pearl millet can be highly effective. No resistance is available in tobacco varieties. Applying a tobacco nematicide for lesion nematode control may be profitable when: 1- significant stunting or crop weakness has already been observed, and 2- a soil nematode assay detects as few as 50-100 lesion nematodes/500 cc of soil.

### APPLICATION METHODS

The performance and safety of a chemical is dependent on the use of proper application methods. Improper pesticide use can reduce yields as severely as any pest and will not provide satisfactory disease control. Proper pesticide use depends upon correct diagnosis of the problem, a clear understanding of the label for each chemical being applied, proper calibration of application equipment, and strict adherence to label directions and all federal, state and local pesticide laws and regulations.

**Table 8. Tobacco disease resistance possessed by selected flue-cured tobacco varieties available in 2017.**

Variety	Ph gene (race 0 only) <sup>2</sup>	Resistance Rating <sup>1</sup>			Nematodes		
		Black Shank		M. <i>incognita</i>	Root-Knot		
		Race 1	Granville Wilt		Other species <sup>3</sup>	TCN	TMV <sup>4</sup>
CC 13	-	46	54	+	+	-	-
CC 27	+	32	76	+	-	+	+
CC 33	-	63	66	+	+	-	-
CC 35	-	43	21	+	+	-	-
CC 37	+	50	82	+	+	+	+
CC 67	+	61	79	+	-	+	+
CC 143 <sup>5</sup>	-	76	64	+	-	-	-
CC 700	+	55	52	+	-	+	-
CC 1063	-	82	71	+	-	-	-
GF 318	+	43	56	+	-	+	-
<b>GL 26H<sup>5</sup></b>		<b>43</b>	<b>53</b>	+	-	-	+
GL 395 <sup>5</sup>	-	62	63	+	-	-	-
K 326	-	30	39	+	-	-	-
K 346	-	80	73	+	-	-	-
NC 72	+	38	58	+	-	+	-
NC 196	+	65	59	+	-	+	-
NC 297 <sup>5</sup>	+	31	60	+	-	+	+
NC 299	+	42	57	+	-	+	-
NC 606	-	69	76	+	-	-	-
NC 925 <sup>5</sup>	-	82	49	+	-	-	-
<b>NC 938<sup>5</sup></b>	-	<b>86</b>	<b>60</b>	+	-	-	-
PVH 1118	+	61	45	+	-	+	-
PVH 1452	+	68	74	+	-	+	-
<b>PVH 1600<sup>5</sup></b>	+	<b>44</b>	<b>42</b>	+	-	+	-
PVH 2110	-	41	50	+	-	-	-
<b>PVH 2254<sup>5</sup></b>	-	<b>51</b>	<b>53</b>	+	-	-	+
PVH 2275	+	10	58	+	+	+	+
PVH 2310 <sup>5</sup>	-	26	39	+	-	-	+

<sup>1</sup> Resistance rating = average % plants still alive near 2<sup>nd</sup> harvest, without a soil fungicide or fumigant. See Tables 3 and 4 for more detailed information.

<sup>2</sup> Varieties with the *Php* gene are almost immune to race 0 of the black shank pathogen; resistance to race 0 without the *Php* gene is at least as high as resistance to race 1.

<sup>3</sup> “Other species” of root-knot nematode include *Meloidogyne arenaria* (peanut root-knot nematode) or *M. javanica* (Javanese root-knot nematode. These other species are now common in Virginia. TCN = Tobacco Cyst Nematode.

<sup>4</sup> TMV = Tobacco Mosaic Virus.

<sup>5</sup> Ratings based on limited data available. Varieties in bold are new for 2017 growing season.

**Preplant Incorporated (Preplant)** - Refer to section under weed control.

**Foliar Spray (FS) – Greenhouse applications** should not begin until seedlings are at least the size of a dime, but if repeated, should be applied at 5-7 day intervals up to transplanting. Use flat-fan, extended range tips at approximately 40 psi to maximize results. **Field sprays targeting the soil surface** should be applied using spray tips that evenly distribute the spray solution at spray volumes between 25 and 40 gallons per acre. **Field sprays for leaf diseases** should generally be applied using tips that apply a fine spray of 20-100 gallons per acre at 40-100 psi to maximize coverage as plants increase in size. Both the tops and bottoms of leaves need to be covered. Use of drop nozzles will significantly improve disease control after layby by improving spray coverage on bottom leaves, where foliar diseases are usually concentrated.

**Fumigation:** - Fumigant Management Plans (FMPs) are required for use of tobacco soil fumigants containing chloropicrin (Pic+ and Telone C-17, for example) or metam sodium (Sectagon, for example). Tobacco producers who plan to fumigate soil need to familiarize themselves with all documentation, applicator safety, Good Agricultural Practices (GAPs), posting, buffer zone, re-entry, and other requirements involved with use of the specific fumigant product they plan to use. These requirements are detailed in the extensive labels for all soil fumigants.

**Precautionary and Restriction Statements** - Read and follow all directions, cautions, precautions, restrictions, and special precautions on each product label. Take labels seriously. This publication must not be used as the only source of precautionary and restriction statements.

**Table 9. DISEASES OF TOBACCO SEEDLINGS**

Disease	Material	Rate
<b>Angular Leaf Spot or Wildfire (<i>Pseudomonas</i>)</b>	Agri-mycin 17, Fire-wall 17WP, Harbour, etc.	100-200 ppm (2-4 tsp/3gal)
<b>Remarks:</b> Foliar Spray- 100 ppm = 4 oz/50 gal or ½ lb/100 gal; preventative use. 200 ppm = ½ lb/50 gal or 1 lb/ 100 gal; curative use.		
<b>Anthracnose</b> ( <i>Colletotrichum gloeosporioides</i> )	Penncozeb 75DF Roper DF Rainshield	0.5 lb/100 gal (1 level tsp/gal)
<b>Blue Mold</b> ( <i>Peronospora tabacina</i> ); <b>Target Spot</b> ( <i>Thanatephorus cucumeris</i> )		
<b>Remarks:</b> Apply as a fine foliar spray to the point of run-off to ensure thorough coverage. Begin applications before disease has been observed, but not before seedlings are the size of a dime. Use 3 gal of spray mixture /1000 sq. ft. when plants are about the size of a dime. Use 6 gal /1000 sq. ft. when the canopy has closed and plants are close to ready for transplanting. Repeat applications on a 5-7 day interval to protect new growth.		

**Table 9. DISEASES OF TOBACCO SEEDLINGS (Cont'd)**

Disease	Material	Rate
<b>Target Spot</b> <i>(Thanatephorus cucumeris)</i>	Quadris	0.14 fl oz (4 ml)/1,000 sq.ft. (6.0 fl oz/A)
<b>Remarks:</b> Apply in enough water for thorough coverage (5 gal/1,000 sq. ft.). The Special Local Need (24[c]) label allows only 1 application before transplanting, and requires the label be in the possession of the user at the time of application. Follow-up sprays are allowed in the field according to the Quadris federal label.		
<b>Blue mold</b> <i>(Peronospora tabacina)</i>	Aliette	0.5 lb (8 oz)/50 gal
<b>Remarks:</b> Foliar spray; apply no more than 0.6 lb/1,000 sq.ft; <b>CAN BURN PLANTS IF WASHED INTO MEDIA OR FLOAT WATER;</b> no more than 2 sprays/greenhouse season.		
<b>Pythium Root Rot</b> <i>(Pythium spp.)</i>	Terramaster 4EC	<u>Preventative:</u> 1 fl oz/100 gal <u>Sequential:</u> 1 fl oz/100 gal <u>Curative:</u> 1.4 fl oz/100 gal <u>2<sup>nd</sup> Curative:</u> 1-1.4 fl oz/100 gal.
<b>Remarks:</b> Can be used before or after symptoms appear, but no earlier than 2 weeks after seeding. If symptoms reappear, a second application can be made no later than 8 weeks after seeding. No more than 2.8 fl.oz./100 gallons of water may be applied to any crop of transplants, regardless of the number of applications.		
<b>MUST BE EVENLY DISTRIBUTED.</b> When mixing, <i>first form dilute emulsion</i> , then distribute diluted emulsion evenly and thoroughly in float bed water.		
<b>Tomato Spotted Wilt Virus</b> (TSWV)	Actigard 50WG	1-2 oz/100,000 plants (~350- 288-cell trays)
<b>Remarks:</b> One foliar application in the greenhouse 5-7 days prior to transplanting in sufficient water to ensure good coverage (~6 gal/1,000 sq. ft.); <b>use of accurate rate is critical to avoid crop injury.</b> In general, a 10-15% stand loss due to TSWV should be expected before considering application of Actigard to tobacco seedlings. Use of systemic insecticides such as imidacloprid or thiamethoxam as well as Actigard will significantly improve control of TSWV. Tank-mixtures are not recommended, but product may be left on foliage or washed off into the root ball.		

**Table 9. FIELD DISEASES OF TOBACCO: ROOT AND STEM DISEASES**

Product	Rate/A	Application Method <sup>1</sup>	Disease <sup>2</sup>	
			Black Shank	Granville wilt
Ridomil Gold SL	1-3 pt	PPI	F	---
Ultra Flourish	2-6 pt	PPI	F	---
MetaStar 2E AG	4-12 pt	PPI	F	---
Ridomil Gold SL	1 pt + 1 pt	PPI + layby	VG	---
Ultra Flourish	2 pt + 2 pt	PPI + layby	VG	---
MetaStar 2E AG	4 pt + 4 pt	PPI + layby	VG	---
Ridomil Gold SL	4-8 fl oz + 1.0 pt	TPW <sup>3</sup> + 1 <sup>st</sup> cultivation and/or layby	VG	---
Ridomil Gold SL	1 pt + 1 pt	1 <sup>st</sup> cultivation + layby	VG	---
Ultra Flourish	2 pt + 2 pt	1 <sup>st</sup> cultivation + layby	VG	---
MetaStar 2E AG	4 pt + 4 pt	1 <sup>st</sup> cultivation + layby	VG	---
Ridomil Gold SL	1 pt + 1 pt + 1 pt	PPI + 1 <sup>st</sup> cultivation + layby	VG	---
Ultra Flourish	2 pt + 2 pt + 2 pt	PPI + 1 <sup>st</sup> cultivation + layby	VG	---
MetaStar 2E AG	4 pt + 4 pt + 4 pt	PPI + 1 <sup>st</sup> cultivation + layby	VG	---
Orondis Gold 200 <sup>4</sup> + Ridomil Gold SL	4.8 fl oz + 6-8 fl oz	TPW <sup>3</sup> or 1 <sup>st</sup> cultivation and/or layby	VG	---
Presidio <sup>5</sup>	4.0 fl oz	1 <sup>st</sup> cultivation or layby	VG	---
Telone C-17	10.5 gal	F-Row	P-F <sup>6</sup>	G
Chlor-O-Pic	3 gal	F-Row	P-F <sup>6</sup>	G
Chloropicrin 100	3 gal	F-Row	P-F <sup>6</sup>	G
Pic Plus	4 gal	F-Row	P-F <sup>6</sup>	G

<sup>1</sup>PPI – broadcast, preplant-incorporated spray; TPW – addition of fungicide to water applied to furrow during transplanting; <sup>1<sup>st</sup></sup> cultivation – broadcast spray just before 1<sup>st</sup> cultivation; layby – broadcast spray just before layby; F-Row – inject 8 inches deep in row with single shank in center of row. Do not apply more than 3 pt of Ridomil Gold or Orondis Gold B, 6 pt of Ultra Flourish, 12 pt of Meta Star 2E AG, 38.6 fl oz Orondis Gold 200, or 8 fl oz Presidio per acre per season.

<sup>2</sup>Control rating – F=fair; G=good; VG=very good. (-) – No disease control or not labeled for this disease.

<sup>3</sup>Apply in at least 100-200 gallons of transplant water (TPW) per acre, followed by at least 1 subsequent fungicide application for black shank control. There is a risk of temporary plant injury from TPW application at lower rates of water per acre. Pre-mixing the soil fungicide in a TPW nurse or source tank also reduces risk of plant injury.

<sup>4</sup>May be applied TPW, 1<sup>st</sup> cultivation or layby, but not sequentially. To avoid fungicide resistance, applications must be alternated with Presidio or Ridomil Gold alone and must also be tank-mixed with Ridomil Gold SL. Use higher rates for heavier soils or more susceptible varieties. Do not follow soil applications with foliar sprays.

<sup>5</sup>Apply Presidio as a field spray after use of a different fungicide at or near transplanting. Presidio may be applied at 1<sup>st</sup> cultivation or layby, but not both.

<sup>6</sup>Fumigants will not control black shank without use of a soil fungicide, but may further improve control from application(s) of a black shank fungicide.

**Table 10. FIELD DISEASES OF TOBACCO: FOLIAR DISEASES**

Disease	Material	Rate <sup>1</sup>	Application Method <sup>2</sup>
<b>Blue mold</b> <i>Peronospora tabacina</i> ; Tomato	Actigard 50WP	0.5 oz/20 gal/A	Foliar
<b>Spotted Wilt Virus (TSWV)</b>			
<b>Blue mold</b> <i>Peronospora tabacina</i>	Aliette	2.5-4.0 lb/A	Foliar
<b>Remarks:</b> Begin applications when blue mold disease threatens and plants are 12 inches tall. Up to 3 sprays may be applied on a 10-day schedule. Treated plants require 3-5 days to fully respond to each application. TSWV sprays beginning within 7 days of transplanting or whenever plants have recovered from transplant shock may also be used to follow-up on greenhouse application of Actigard for TSWV control.			
<b>Blue mold</b> <i>Peronospora tabacina</i>	Revus	8.0 fl.oz/A	
<b>Remarks:</b> No more than 5 sprays allowed, 3 day pre-harvest interval; don't tankmix.			
<b>Blue mold</b> <i>Peronospora tabacina</i>	Ridomil Gold EC	0.5-1 pt + 0.5 pt/A	Preplant +
<b>Remarks:</b> Foliar spray; begin application before disease develops and continue on a 7-10 day interval. Switch a non-FRAC Group 40 fungicide after 2 consecutive sprays. May be tank-mixed with an effective blue mold fungicide that has a different mode of action. Use sufficient spray volume to provide thorough coverage. Adding a spreading/penetrating surfactant (non-ionic) may improve results.			
<b>Blue mold</b> <i>Peronospora tabacina</i>	Ultra Flourish	1-2 pt + 1 pt/A	Layby
<b>Remarks:</b> Strains of the blue mold pathogen are often insensitive to mefenoxam, but mefenoxam may control sensitive strains early in the season, as well as <i>Pythium</i> damping-off. Read precautionary and rotation crop restrictions.			
<b>Blue mold</b> <i>Peronospora tabacina</i>	MetaStar 2E AG	2-4 pt + 2pt	
<b>Blue mold</b> <i>Peronospora tabacina</i>	Forum + Penncozeb 75 DF	7.0 fl oz + 2.0 lb/100 gal water	Foliar Spray
<b>Remarks:</b> Begin sprays conditions favor disease. Continue applications on a 5-7 day interval until the threat of disease subsides. Apply 20 to 30 gal/A of spray solution during the first several weeks after transplanting and gradually increase spray volume as the crop grows. Spray volumes should reach 40 gal/A by layby and should range between 80 and 100 gal/A on tobacco ready to be topped. Do not exceed 8 fl.oz./A of Forum per application or 30 fl.oz./A per season. Tank-mixes with mancozeb shouldn't be applied after the early button stage or within 21 days of the first harvest.			
<b>Blue mold</b> <i>Peronospora tabacina</i>	Orondis Ultra A + Orondis Ultra B	2.0 - 4.8 fl oz + 2.0 - 4.8 fl oz/100 gal water	Foliar Spray
<b>Remarks:</b> Begin sprays when conditions favor disease. Continue applications on a 7-10 day interval until the threat of disease subsides. Use higher rates when disease is already present, for longer application intervals, or for more susceptible varieties. Apply 20-30 gal/A of spray solution during the first several weeks after transplanting and gradually increase to 40 gal/A by layby and 80-100 gal/A on tobacco ready to be topped. Do not exceed 19.2 fl.oz./A per season. Do not follow soil use of Orondis with foliar application. Make no more than 2 sequential applications before rotating to a different fungicide to avoid fungicide resistance.			

**Table 10. FIELD DISEASES OF TOBACCO: FOLIAR DISEASES (Cont'd)**

Disease	Material	Rate <sup>1</sup>	Application Method <sup>2</sup>
<b>Blue mold</b> ( <i>Peronospora tabacina</i> ); Frogeye ( <i>Cercospora nicotianae</i> ); <b>Target Spot</b> ( <i>Thanatephorus cucumeris</i> )	Quadris	6-12 fl. oz.	Foliar Spray
<b>Remarks:</b> First application for blue mold should be made at first indication of disease in the area; for target spot, spray at or soon after layby; don't spray Quadris "back-to-back" for blue mold, but alternate with another fungicide; spray sufficient water volume for complete coverage and canopy penetration; may enhance weather flecking, but this shouldn't affect yield or quality; up to 4 applications/year allowed; but residues are a concern of the tobacco industry; may be applied up to the day of harvest; tankmixing with insecticides formulated as ECs or containing high amounts of solvents may cause some crop injury.			

<sup>1</sup>Use higher rates of protectant fungicides for mature plants.

<sup>2</sup>**Foliar spray** - apply at 40-100 psi in 20 to 100 gal of water. The amount of water depends on size of plant. Use hollow-cone nozzles (TX12, etc.) Use drop nozzles to apply fungicide to both the top and bottom leaves. Preplant + layby - first application preplant followed by a second spray just before last cultivation.

**Table 11. TOBACCO NEMATICIDES**

Product	Rate/A, Application Method <sup>2</sup>	Nematodes <sup>1</sup>	
		Root-Knot and Others	Tobacco Cyst
<b>Fumigants</b>			
Chlor-O-Pic	3- 4 gal, Row	E	G
Metam CLR	25 gal, Row	---	G
Pic Plus	4.2 gal, Row	E	G
Telone II	9-10 gal, Row	E	G
Telone C-17	10.5 gal, Row	E	G
<b>Non-Fumigants</b>			
Nimitz <sup>3</sup>	3.5-7.0 pt/tA; Band-PPI	?	?

<sup>1</sup> Control ratings: E=Excellent; G=Good; F=Fair; P=Poor; ? = insufficient data available to provide reliable evaluation; (---) =no control or not labeled. Use higher rates for higher nematode populations or for heavier soils.

<sup>2</sup> PPI= before planting, apply broadcast in 40 gal/A, use at least 20 gal/A if applied in an 18-24 inch-wide band; incorporate 4-6 inches deep as soon as possible; Row=inject 8 inches deep in row with single shank - 21-day waiting period before planting.

<sup>3</sup>Nimitz should be applied in a band over the center of preformed beds and incorporated at least 7 days before transplanting. Product label rates are expressed per **treated acre** (not planted acre).

**DISEASES OF TOBACCO****There Are No Chemical Controls For the Following Diseases**

Disease	Remarks
Botrytis Blight ( <i>Botrytis cinerea</i> )	A wet rot is often first observed on stems or leaves. A gray, downy material may be present on the surface of diseased areas. In the greenhouse, reducing surface moisture on leaves and stems by correct watering and improved ventilation, and collecting and removing loose-leaf material from clipping, will help reduce damage. "Greenhouse management practices effective for collar rot and target spot also help reduce incidence and severity of Botrytis blight. Occurrence of this disease is extremely rare in the field, but when observed, was associated with topping plants very late in very wet weather."
Brown Spot ( <i>Alternaria alternata</i> )	Can be severe on mature tobacco, especially during periods of high humidity. Avoid leaving mature leaves in the field. Good sucker control also helps reduce disease incidence.
Collar Rot ( <i>Sclerotinia sclerotiorum</i> )	Symptoms resemble damping-off. Small groups of plants have brown, wet lesions near the base of stems. Leaf rot may appear to progress from leaf margins or tips toward the stem. White, cottony, mold may be visible. Irregularly shaped, white to black objects (sclerotia) may also be found attached to severely infected plant parts. Infected plants, as well as plants immediately adjacent to diseased areas, should be discarded as soon as possible. Improving ventilation, reducing excess moisture, proper clipping procedures, and controlling target spot may help reduce disease.
Frenching (nonpathogenic causal agent)	This disorder has been associated with toxins produced by a nonpathogenic bacterium, <i>Bacillus cereus</i> , and other nonpathogenic microorganisms. Frenching is more prevalent on wet, poorly aerated soils. This problem can be more severe on neutral or alkaline soils and is sometimes associated with lack of available nitrogen or other minerals. Proper drainage and fertilization can be beneficial. Do not plant in alkaline soils and avoid heavy applications of lime.
Weather Fleck (ozone)	This disorder appears as small brown to tan leaf spots in the plant bed and field. The major cause of this problem is ozone from thunderstorms and/or air pollution. Hot humid days followed by heavy rains increase severity of problem.

