MINIMIZING TOBACCO FIELD DISEASES

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Despite tobacco growers' best efforts, years with high disease incidence can occur. This happens when there is an abundance of disease pathogens, when growers plant varieties with some level of disease susceptibility, and when weather is ideal for disease development. While a season such as this is historically the exception rather than the rule, weather for the upcoming year cannot be accurately predicted. Therefore, tobacco producers must prepare for every year like it is going to be a growing season in which conditions conducive to significant disease development will occur. Producers can take proactive and reactive steps now to minimize tobacco field diseases for upcoming seasons:

- Proactive strategies are preventative measures and tools used in early planning stages through crop establishment to lay a solid disease prevention foundation. These practices will not only prevent or minimize many field diseases, but they also will eliminate or reduce other problems, such as poor growth, vigor, or plant health due to inadequate fertility or improper pH. These all contribute to tobacco yield and quality.
- Reactive strategies rely on thorough and regular monitoring of the crop throughout the season, disease symptom recognition and accurate diagnosis, and timely application of the correct tool for the correct problem.

Combined implementation of both types of strategies will be essential to minimize tobacco diseases in seasons to come. Below are best production practices, separated by strategy, which every tobacco producer should employ.

Figure 1. Black Shank

Figure 2. Fusarium Wilt

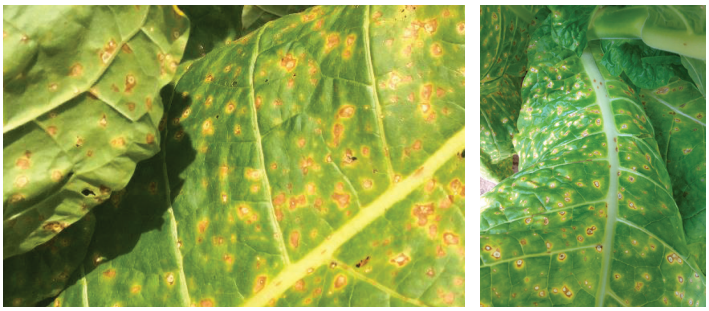

Figure 3. Frogeye Leaf Spot

Figure 4. Target Spot

Figure 5. Angular Leaf Spot

PROACTIVE STRATEGIES

Some diseases, such as black shank ***(Figure 1)*** and Fusarium wilt ***(Figure 2)***, can only be effectively managed by preventative approaches. If proactive measures to minimize these diseases are not initially taken, reactive measures will not help the situation later.
These include:

Site selection (crop rotation)

Setting tobacco in a site that has been out of tobacco for at least three years is always a best recommended practice, and widespread disease in the preceding year makes this practice even more important for the upcoming year. In severe disease years, significant leaf loss in the field can cause an abundance of foliar disease inoculum in soils. Planting these fields back to tobacco the following year would be expected to result in continued high levels of foliar disease, such as frogeye leaf spot ***(Figure 3)***, target spot ***(Figure 4)*** and angular leaf spot ***(Figure 5)***. Similarly, any site with severe black shank should not be re-set in tobacco the following year. For example, 2016 was the worst year for black shank diagnoses since 2010 ***(Figure 6)***, and even fields with no known history had the disease in 2016. For effective black shank management, the three-way approach of crop rotation, resistant varieties and fungicide application optimizes yields. If black shank pathogen populations are present in soil and environmental conditions are right, black shank can overwhelm resistant varieties and effective fungicides. Rotate tobacco to a fertile, well-drained site that has been out of tobacco for at least three years. If such a site is not available, some rotation is better than none; the more years out of tobacco, the better.

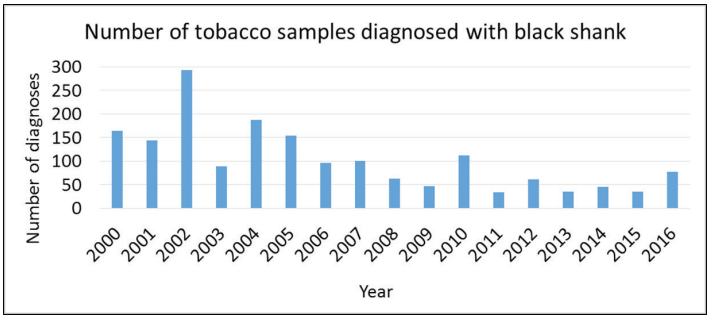

Figure 6: Tobacco samples submitted to the Lexington, Kentucky, Plant Disease Diagnostic Laboratory diagnosed with black shank, from 2000 to 2016. Many factors affect sample diagnoses, including number of tobacco growers, total tobacco acreage, and changes in county and state extension personnel. Diagnoses were conducted by Paul Bachi, Julie Beale, and Brenda Kennedy, University of Kentucky.

Soil test, then apply lime and fertilizer based on soil test results

Once a suitable site has been selected, it is imperative to soil test, then apply lime and nutrients based on test results. Adequate fertility builds upon the foundation of a healthy site and will minimize transplant shock, ensure establishment and sustain crop growth. Crops are most likely to stay healthy when they are unstressed and properly nourished, and therefore, are less susceptible to diseases when unstressed by such factors as drought, frequent rains, overfertilization or nutrient deficiencies. Overfertilization with some nutrients, such as nitrogen, can be just as damaging as too little. For example, too much nitrogen can result in lush,

Figure 7. Boron deficiency

Figure 8. Manganese toxicity

Figure 9. Blue mold

Figure 10. Bacterial leaf drop

Figure 11. Brown spot

tender growth that is more susceptible to pathogen infection. This lush growth may also increase humidity and decrease airflow through the crop canopy, which enhances pathogen survival, growth, development and increased disease. Likewise, too low or too high pH can facilitate pathogen survival in soil as well as influence nutrient availability to the point that reduced plant growth and damage occurs. For example, fields with high soil pH levels have been associated with increased black shank, black root rot and boron deficiency ***(Figure 7)***, whereas low soil pH levels can result in manganese toxicity ***(Figure 8)*** and molybdenum deficiency. High N levels favor black root rot, blue mold ***(Figure 9)*** and bacterial diseases ***(Figure 10)***, while low N can increase target spot and brown spot ***(Fig.11)***. Therefore, consult information resources on recommended fertilization levels and amend with lime and/or nutrients accordingly for best results ***(Table 1)***. Soil samples should be collected in the fall prior to the planned tobacco crop, and lime should be fall-applied in order to allow time for the lime to adjust pH to a target range of 6.2 to 6.6. This should ensure that pH does not fall below 5.8 to 6.5, the range in which tobacco grows best.

Variety selection

Varietal resistance is an essential tool that should be utilized by all tobacco producers with known disease problems, yet this should not be the sole disease management approach. Several dark and burley varieties with good black shank resistance to races 0 and 1 also offer high yield potential and good quality ***(Tables 2 and 3)***. Producers should utilize these varieties in fields with a history of black shank (if these areas can't be avoided), and evaluate at least one or two resistant varieties on their farms by comparing them to their preferred varieties in areas without black shank pressure. Research conducted by the University of Tennessee and the University of Kentucky has shown that while variety resistance to black shank markedly reduces black shank losses, these varieties should be combined with effective fungicide(s) and set on a site that has been out of tobacco at least three years to achieve the best results. Black shank resistance alone, even combined with an effective fungicide, may not be enough to adequately prevent yield loss. Furthermore, high black shank pressure, such as that found in continuous tobacco fields, may overwhelm genetic resistance and reduce yields, even if resistance masks obvious disease symptoms. This has led to some claiming that new varieties do not yield as well as older varieties. However, growers who make these claims may not realize that using an older variety with little or no black shank resistance in the same site may have resulted in limited plant survival. Varietal resistance to foliar diseases such as frogeye leaf spot, target spot and angular leaf spot is not currently available.

Preventative fungicide application for black shank control

Like varietal resistance, fungicide application alone should not be relied upon to achieve satisfactory black shank control. However, soil-applied fungicides are proven, available tools that can minimize losses caused by black shank when combined with crop rotation, site selection and resistant varieties. Several effective fungicide and application options are available to producers (Table 4). Transplant water fungicide application is particularly recommended on any site with a history of black shank, and up to two additional, soil-directed applications may be necessary for adequate management in challenging years. These soil-directed applications are most effective when cultivated in. Any time chemicals are used, it is critical that they are applied at labeled rates and recommended volumes to maximize control.

Table 1. Resources of information on soil testing and recommended levels of fertilization for burley and dark tobacco.

Table adapted from 2017-2018 Burley and Dark Tobacco Production Guide.

State	Publication	Title of publication	URL for online version
KY	AGR-1	Lime and Nutrient Recommendations	www2.ca.uky.edu/agc/pubs/agr/agr1/agr1.pdf
TN		Lime and Fertilizer Recommendations for the Various Crops of Tennessee	Lime: ag.tennessee.edu/spp/SPP%20 Publications/chap1-limerecommends2008.pdf Fertilizer: ag.tennessee.edu/spp/SPP%20 Publications/chap2-agronomic_mar2009.pdf

Table 2. Characteristics of selected[a] burley tobacco varieties.

Table adapted from 2017-2018 Burley and Dark Tobacco Production Guide.

Variety	Maturity	Black Shank		Relative Yield Score[b]	Virus Complex[c]	Black Root Rot[c]	TMV[c]	Fusarium Wilt
		Race 0	Race 1					
ms KY 14 X L8LC	Early	10	0	8	S	M	R	6
KY 907LC	Med-Late	2	2	8	R	H	R	1
KT 200LC	Late	6	6	8	R	H	R	0
KT 204LC	Med-Late	7	7	9	R	H	R	1
KT 206LCd	Med-Late	10	6	9	R	H	R	1
KT 209LC	Med-Late	10	8	9	R	H	R	1
KT 210LC	Late	10	8	8	S	H	R	5
KT 212LC	Early	10	4	8	S	H	R	5
KT 215LC	Late	10	9	9	S	H	S	8
NC BH 129LC	Med-Early	1	1	7	S	H	R	1
NC 3LCe	Med-Late	2	2	7	R	H	R	1
NC 7LCe	Late	10	4	8	R	H	R	5
NC 2000LCf	Late	0	0	4	S	L	R	1
NC 2002LCf	Medium	0	0	5	R	M	R	0
TN 86LC	Late	4	4	6	R	H	S	0
TN 90LCd	Medium	4	4	5	R	H	R	0
TN 97LC	Med-Late	4	4	6	R	H	R	0
HYBRID 403LC	Medium	0	0	9	S	M	R	6
HYBRID 404LC	Medium	0	0	9	Sg	Hg	Rg	4
HYBRID 501LC	Med-Early	5	5	5	S	H	R	4
N 126LC	Medium	0	0	8	S	S	R	3
N 777LC	Med-Late	2	2	3	S	M	S	0
N 7371LC	Late	4	4	7	S	–	–	5
NBH 98LC	Medium	2	2	5	S	M	R	3
HB04PLC	Med-Early	0	0	9	S	H	R	0
HB3307PLC	Late	10	5	8	R	H	S	3
HB4488PLC	Late	10	4	9	R	H	–	3
R 610LC	Medium	4	4	5	S	M	–	3
R 630LC	Early	3	3	5	R	M	R	4
R7-12LC	Late	0	0	8	S	H	R	4

[a] *For an extensive list of varieties, go to http://www.uky.edu/Ag/Tobacco.*
[b] *Relative yield scores are based on growth under disease-free conditions.*
[c] *Dash (-) means that resistance level is unknown or not rated at present.*
[d] *Low resistance to blue mold (Peronospora tabacina).*
[e] *Resistant to root knot nematode (Meloidogyne incognita, Races 1 and 3).*
[f] *Medium resistance to blue mold (Peronospora tabacina).*
[g] *Based on a limited number of field tests and subject to change.*

Table 3. Characteristics of dark tobacco varieties.

Table adapted from 2017-2018 Burley and Dark Tobacco Production Guide.

Variety	Maturity	Black Shank (0-10)[a]		Use[b]	Relative Yield Score[c]	Relative Quality Score[c]	Black Root Rot[d]	TMV[d]	Wildfire[d]
		Race 0	Race 1						
NL Mad LC	Med-Late	0	0	F/A	7	9	None	None	None
TR Madole	Early-Med	0	0	F	6	6	None	None	None
Lit Crit	Med-Late	0	0	A/F	5	9	None	None	None
KY 160	Medium	0	0	A	3	9	None	High	None
KY 171e	Medium	0	0	A/F	7	7	High	High	None
DF 911	Medium	0	0	F	8	6	High	High	High
VA 309	Early-Med	2	2	A/F	6	7	Low	None	-
VA 359	Medium	1	1	A/F	6	7	Low	None	-
TN D950	Early	3	3	F	8	6	High	High	High
KT D6LC	Early-Med	3	3	F	8	7	High	High	High
KT D8LC	Medium	4	4	F/A	9	5	None	None	None
KT D14LC	Medium	10	5	F/A	8	7	High	High	High
DT 538 LC	Medium	4	4	F/A	8	6	High	-	-
DT 558LC	Medium	4	4	F/A	8	7	High	-	-
PD 7302LCe	Medium	10	0	F/A	6	7	High	High	-
PD 7305LC	Early	10	3	F	8	6	High	High	High
PD 7309LC	Medium	10	0	F/A	7	8	None	None	-
PD 7312LC	Medium	0	0	A/F	7	8	High	High	None
PD 7318LC	Medium	10	0	F/A	8	7	High	High	-
PD 7319LC	Medium	10	2	F/A	8	7	-	High	-

[a] Black shank resistance levels are based on a limited number of field tests and subject to change.
[b] F or A refers to use as a fire-cured or air-cured variety. F/A indicates either use with predominant use given first.
[c] Relative yield scores based on performance under disease-free conditions. Relative yield and quality scores given on a 0-10 scale, with 10 being best for the predominant use.
[d] Dash (-) means that resistance level is unknown or not rated at present.
[e] KY 171, PD 7302LC, and PD 7312LC have medium resistance to Fusarium wilt.

Table 4. Guide to fungicides available for control of black shank.
Table adapted from 2017-2018 Burley and Dark Tobacco Production Guide.

Fungicide (FRAC Code)	Season Rate/A	Pre-transplant or at-transplanting applications			Post-plant applications	
		Method	Rate/A*	Remarks	Rate/A*	Remarks
Ridomil Gold SL (4)	3 pt	Pre-plant only	1-2 pt	Apply to soil within 1 week before planting and incorporate into the top 2-4 inches of soil.	--	--
		Pre-plant + post-plant	1 pt	Apply to soil within 1 week before planting and incorporate into the top 2-4 inches of soil.	1 pt	Make first application as near as possible to transplanting if no pre-plant application was made or if black shank is expected early in the season. Otherwise, make application(s) at layby or at first cultivation and layby.
		Transplant water + Post-plant	¼-½ pt	Apply in no less than 200 gallons of transplant water per acre.	1 pt	Make subsequent application(s) at first cultivation and/or layby.
Ultra Flourish (4)	6 pt	Pre-plant only	2-4 pt	Apply to soil within 1 week before planting and incorporate into the top 2-4 inches of soil.	--	--
		Pre-plant + post-plant	2 pt	Apply to soil within 1 week before planting and incorporate into the top 2-4 inches of soil.	2 pt	Make first application as near as possible to transplanting if no pre-plant application was made or if black shank is expected early in the season. Otherwise, make application(s) at layby or at first cultivation and layby.
MetaStar 2E (4)	12 pt	Pre-plant only	8-12 pt	Apply to soil just prior to planting and incorporate into the top 2-4 inches of soil.	--	--
		Pre-plant + post-plant	4 pt	Apply to soil just prior to planting and incorporate into the top 2-4 inches of soil.	4 pt	Do not make a post-plant application of MetaStar if more than 4 pt was used pre-plant or if none was used pre-plant. Post-plant application(s) may be made at layby or at first cultivation and layby.
Orondis Gold 200 (U15)	36.4 fl oz	Transplant water	4.8-fl oz	Apply mixed with 6-8 fl oz Ridomil at planting, in furrow or in transplant water. Rates up to 19.2 fl oz/A are labeled, such as in heavier soils. Apply in no less than 200 gallons of transplant water per acre.	4.8 - 19.2 fl oz	Apply mixed with 6-8 fl oz Ridomil, as a banded post-plant application to the soil at first cultivation or layby. Rates up to 19.2 fl oz/A are labeled, such as in heavier soils. Do not use if Orondis Gold has already been applied.
Presidio (43)	8 fl oz	--	--	--	4 fl oz	Make banded application directed at soil beneath leaves at first cultivation or layby.

** Rate range of product. In general, use the highest labeled rates when disease pressure is high. Refer to product label for application information, restrictions and warnings.*

Table 5. Guide to chemicals available for control of tobacco diseases in the field.
Table adapted from 2017-2018 Burley and Dark Tobacco Production Guide.

Chemical (Fungicide FRAC Code)	Product Rate Per		PHI[b] (days)	Target Diseases	Label Notes
	Application[a]	Season			
Agricultural Streptomycin, Agri-Mycin 17, Harbour	100-200 ppm (4-8 oz/ 50 gal H2O)	no limit	0	wildfire, angular leaf-spot, blue mold	Use low rate for prevention and higher rate when disease is first observed or in areas with a history of angular leaf-spot.
Actigard 50WG (P1)	0.5 oz	1.5 oz (3 apps.)	21	blue mold	Begin applications when plants are greater than18 inchesc in height. Actigard must be applied 4-5 days prior to infection to allow for activation of plant defense compounds. Do not apply to plants that are stressed from drought or other environmental factors. Make up to three applications in at least 20 gal/A on a 10-day schedule
Mancozeb (Manzate Pro-Stick, Penncozeb DF, Roper DF Rainshield) (M3)	1.5-2 lb	no limit	30	blue mold, anthracnose	Mancozeb residues are an industry concern, so use this product only as a tank-mix with Forum or Presidio, alternated with Quadris, Revus or Orondis Ultra. Only Manzate ProStick is labeled in most burley states, while Penncozeb DF and Roper DF Rainshield are labeled in VA.
Aliette WDG (33)	2.5-4 lb	20 lb	3	blue mold	Make first application immediately after transplanting; continue on a 7- to 10-day schedule. Increase rate and application volume (20-100 gal/A) as crop size increases.
Forum (formerly Acrobat) (40)	2-8 fl oz	30 fl oz	0	blue mold	Increase rate and application volume (20-100 gal/A) as crop size increases. Forum must be tank-mixed with another blue mold control product, such as mancozeb, for resistance management. Neither Ridomil Gold, Ultra Flourish, MetaStar, Revus nor Actigard are recommended as tank-mix partners for Forum. Do not mix with surfactants, foliar fertilizers or sucker control materials.
Quadris 2.08SC (11)	6-12 fl oz	32 fl oz	0	target spot, frogeye, blue mold	Begin applications before blue mold symptoms appear. For blue mold, continue sprays on a 7- to 14-day schedule (use the shorter spray interval when conditions favor disease). If blue mold is present in the field, apply Forum tank-mixed with a mancozeb fungicide, Revus or Orondis Ultra prior to using Quadris. Do not make back-to-back sprays, but alternate with a different fungicide labeled for tobacco. Can be used up to the day of harvest, but minimize post-topping application, as fungicide residues are a significant industry concern. Do not mix with EC-type pesticides or with sucker control materials.
Revus 2.08SC (40)	8 fl oz	32 fl oz	7	blue mold	Begin applications before blue mold symptoms appear. Continue on a 7- to 10-day schedule. Make no more than two consecutive sprays before switching to a fungicide with a different mode of action (do not alternate with Forum). Addition of a surfactant (spreader/ penetrator or non-ionic) may enhance activity.

Table 5. (continued)

Orondis Ultra A (U15)	2.0-4.8 fl oz	19.2 fl oz		blue mold	Use higher rates when disease is already present. Increase rate and spray volume (20-100 gal/A) as crop size increases. For resistance management, must be tank-mixed with ½ pt Revus, make no more than two sequential applications before rotating to a fungicide with a different mode of action, and do not use if Orondis Gold 200 was applied for black shank control.
Presidio (43)	4 fl oz	8 fl oz	7	blue mold	Apply as a foliar spray prior to disease onset or at first sign that blue mold is in the area. For resistance management, must be tank mixed with another fungicide of different mode of action (FRAC class). A second application can be made with a minimum 7-day interval after the first application. Do not use if Presidio was previously applied for black shank control.

[a] *Rate range of product PER ACRE. In general, use the highest labeled rates when disease pressure is high. Refer to product label for application information, restrictions, and warnings.*
[b] *Preharvest interval*
[c] *Actigard can be applied to dark tobacco varieties at the 12-inch stage.*

Have a proactive mindset

Optimum crop rotations, timely adjustments to soil pH or fertility, and appropriate chemical selection should always be goals for each season, and planning goes a long way to their achievement. However, in field situations where one factor is not achievable, completion of other best practices will still provide benefit. For example, if tobacco must be set in a site with known disease pressure, one should still soil test or amend according to these results. Producers should control what they can to ensure the best foundation on which to produce a crop. While every year and every site have unique constraints, best efforts specific to each situation will consistently achieve the best result.

REACTIVE STRATEGIES

In some years and for some diseases, proactive approaches do not completely manage yield losses. The following reactive measures may be integrated to mitigate the effects of disease:

Scouting

Disease is seldom absent one day, then severe the next, though it may seem this way at times. Regular and thorough crop scouting and monitoring allow producers to implement timely disease management practices. Field perimeters as well as several full inner rows should be evaluated at least every seven to 10 days through the entire season to monitor disease, insect and weed presence, as well as general growth. By doing so, problems may be discovered when these occur in limited areas, and timely application will prevent or minimize pathogen effects on yield and quality.

Accurate, early identification

Once a problem is discovered, it is absolutely essential that an accurate, early diagnosis be made so the proper treatment can be applied in a timely manner to minimize yield and quality losses. Once disease symptoms, insect feeding or changes in the appearance of plants are noticed, take the necessary measures to ensure accurate identification of the cause. This may be accomplished by the experience of the producer, or it may require consultation with an Extension agent, specialist or industry agronomist. See Figures 1-5 and 7-11 for images of common tobacco field diseases and nutrient deficiencies and toxicities.

Correct tool or practice to manage the problem

The correct method to manage an accurately identified problem is essential to prevent or minimize tobacco yield and quality loss. For example, if tobacco has a bacterial disease and the producer applies a fungicide to treat the problem, not only will the treatment be ineffective — fungicides are only effective on fungal diseases — but the producer also wasted valuable time and money that could have been properly directed on the recommended treatment. Remember to choose the right treatment for the right disease. See Table 5 for recommended treatments.

Summary

Tobacco has been an important crop for many years in Tennessee and Kentucky, and though some years are environmentally challenging, many producers have developed their own effective production programs that consistently produce high-yielding, high-quality tobacco. While these programs vary somewhat from individual to individual, the common factor is that these producers control what they can to maximize their chances for a good crop. All successful production programs incorporate at least some of the proactive and reactive approaches discussed above.

SOURCES AND SUGGESTED READING

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