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FLUE-CURED TOBACCO PRODUCTION GUIDE

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Virginia Tech and Virginia State -- Virginia's Land Grant Universities

in cooperation with the

Virginia Tobacco Board

2023 FLUE-CURED TOBACCO

PRODUCTION GUIDE

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Stephen Barts, Extension Agent, Crop and Soil Sciences

Introduction

The flue-cured tobacco budget is an estimate of the costs to produce 2500 pounds of marketable tobacco. Expense values used in the budget are based upon projected input prices and recommended production practices. Every producer is encouraged to adjust this budget using the right hand column to reflect production practices and prices that are relevant to their own farming operation. This column is your estimated cost of production.

Budget Assumptions

1. The average price received is not being calculated or estimated. However, break-even prices to cover cost variable and fixed costs are calculated based on 2500 pounds of cured leaf contracted per acre.
2. The short term energy outlook published monthly by the Energy Information Administration http://www.eia.doe.gov/emeu/steo/pub/contents.html has estimated average prices of fuels for 2023. The price of fuels as assessed on December 16, 2022 are used in the budget and are an estimation.
3. Hired labor cost is estimated to be $17.99 per hour. It includes an unpublished adverse wage of $14.91 and indirect labor cost of $3.08 per hour. The indirect labor cost per hour is calculated by dividing total indirect labor costs of $20,482.00 (association fees, visas, transportation, housing, insurance, etc.) by 6650 hours of labor (70 acres x 95 hours).
4. Crop insurance cost of $248.00 per acre reflects the average farmer-paid premium with the addition of the Supplemental Coverage Option and Enhance Coverage Option.
5. The quantity of curing fuel is estimated based on pounds of cured leaf per gallon of fuel used. Farm cooperators have achieved higher curing efficiency in new barn installations.

Budget Interpretation

Income and expense items for the 2023 budget are broken down into four separate sections: Gross Receipts, Pre-harvest Variable Costs, Harvest Variable Costs, and Fixed Costs. Explanations of the items that fall into each section and the economic returns that can be calculated are detailed below:

- Gross Receipts represents per acre cash income to the tobacco operation. Gross receipts are calculated by multiplying the average yield per acre by the average gross contract price per pound. Four

different leaf separations with a contract price can be entered into an Excel spreadsheet referenced at the end of this section.

- Pre-harvest costs are typically cash expenses that must be paid annually to produce a crop of tobacco prior to harvest. Examples of pre-harvest variable costs include plants, fertilizer, chemicals, machinery fuel and repairs and hired labor.
- Harvest costs are cash expenses getting the tobacco from the field to the buying station. Examples of harvest costs include harvest labor, curing fuel and electricity.
- Total Variable Costs is the sum of pre-harvest and harvest variable costs. Variable costs are often called “cash costs” or “out-of-pocket expenses”.
- Return over variable costs is simply the gross receipts of the crop minus the total variable costs. This value can essentially be viewed as the return over “cash costs” or the return over “out-of-pocket expenses”.
- Fixed Costs are the expenses that result from the ownership of a fixed input. Examples of fixed costs include depreciation, property taxes, and insurance on the barns and machinery. A land charge has been excluded from this calculation.
- The return to land, risk, and management is calculated by subtracting the total variable costs and the fixed expenses from Gross Receipts. This represents the return to the operator’s land (the equivalent of an annual land charge or rental value), time (unpaid operator/family labor), and management skills employed in producing a crop.

FLUE-CURED TOBACCO –Contract, Irrigated

ESTIMATED COSTS AND REURNS PER ACRE **Acres**
2500 POUND YIELD **1**

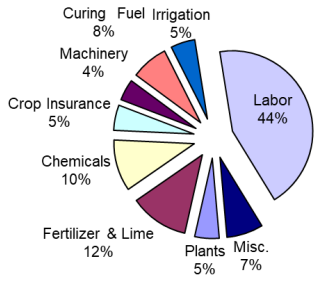
	Unit	Quantity /Acre	Price or Cost/ Unit	Total Acre	Your Farm
1. GROSS RECEIPTS					
Stalk Position Lbs					
Stalk Position Lbs					
Stalk Position Lbs					
TOTAL RECEIPTS:	Lbs				
2. PRE-HARVEST VARIABLE COSTS					
TOBACCO PLANTS -					
Flue-cured	1M	6.20	$38.50	$238.70	
Cover Crop: Rye	BU	2.00	$20.00	$40.00	
Lime (Prorated)	TON	0.56	$47.75	$26.74	
FRow: Fertilizer (6-12-18)	CWT	9.00	$53.45	$481.05	
Sidedress: (15.5-0-0)	CWT	2.00	$33.75	$67.50	
Herbicides	ACRE	1.00	$33.43	$33.43	
Insecticides	ACRE	1.00	$65.72	$65.72	
Fungicides	ACRE	1.00	$89.98	$89.98	
Nematicides	ACRE	1.00	$198.90	$198.90	
Sucker Control	ACRE	1.00	$114.84	$114.84	
Federal Crop & Hail Insurance APH	ACRE	1.00	$248.00	$248.00	
Land Rent	ACRE	1.00	$0.00	$0.00	
Tractor Equip: Fuel & Oil	Eq Gal	61.11	$4.09	$249.94	
Tractor & Equip.: Repairs	ACRE	1.00	$79.09	$79.09	
Tractor & Equip.: Labor	HRS	14.65	$17.99	$263.55	
Hand Production Labor	HRS	35.00	$17.99	$629.65	
Production Interest 6	Months	$1,413.55	8.5%	$120.15	
TOTAL PRE-HARVEST COSTS		**$1.18 Per Pound**		**$2,947.24**	
3. HARVEST VARIABLE COSTS					
Tractor Equip: Fuel & Oil	Eq Gal	17.61	$4.09	$72.02	
Tractor & Equip.: Repairs	ACRE	1.00	$44.48	$44.48	
Tractor & Equip.: Labor	HRS	8.54	$17.99	$153.63	
Hand Harvest Labor	HRS	60.00	$17.99	$1.079.40	
Curing Fuel (LP) 10	gal/cwt	250.00	$1.45	$362.50	
Building Ins. & Electricity	ACRE	1.00	$181.00	$181.00	
Supplies	ACRE	1.00	$16.10	$16.10	
TOTAL HARVEST COSTS:		**$0.76 Per Pound**		**$1,909.13**	
	Breakeven Yield		**Breakeven Price**		
4. TOTAL VARIABLE COST					
2,368 Pounds @ $2.05			**$1.94/ Pound**	**$4,856.37**	
5. RETURN OVER TOTAL VARIABLE COST				**$0.00**	
6. MACHINERY FIXED COSTS (BASED ON NEW EQUIPMENT COST)					
	ACRE	1.00	$856.35	$856.35	
7. OTHER FIXED COSTS	DOL	$4,856.37	8.0%	$388.51	
8. TOTAL FIXED COSTS			$0.50 Per Pound	$1,244.86	
9. TOTAL VARIABLE & FIXED COSTS		**$2.44 Per Pound**		**$6,101.23**	
10. PROJECTED NET RETURNS TO LAND, RISK AND MANAGEMENT:				**$0.00**	

* PLEASE NOTE: THIS BUDGET IS FOR PLANNING PURPOSES ONLY.

Profit Analysis

Based upon budget projections, the "Total Variable Costs or Cash Costs" of production for the 2023 crop are estimated at $4,856.37 per acre or $1.94 a pound. The breakdown of variable costs is displayed in Figure 1. Fixed Costs were estimated at $1,244.86 an acre or $0.50 a pound. Farmers must be able to cover fixed costs in the long run for the farm business to be sustainable.

Figure 1. Breakdown of Variable (Cash) Costs



The price needed to cover total cost with varying yields is in the following table. It also calculates additional prices needed to generate varying profit levels that can pay for family living expenses.

Since yield and average sale price will vary from farm to farm each year, calculated returns over variable costs with varying yield and price levels are displayed in the following table.

AVERAGE PRICE ($/lb.) NEEDED TO COVER TOTAL COSTS (VARIABLE AND FIXED)[1]

FARM YIELD			Desired Net Income per Acre Above Total Costs				
Lbs.	TOTAL COST/ ACRE	Fixed Cost /Lb	$0.00	$250.00	$500.00	$750.00	$1,000.00
			-- Average Price Needed to Cover Total Cost ($/Lb) --				
2000	$6,028.73	0.62	$3.01	$3.14	$3.26	$3.39	$3.51
2250	$6,064.98	0.55	$2.70	$2.81	$2.92	$3.03	$3.14
2500	$6,101.23	0.50	$2.44	$2.54	$2.64	$2.74	$2.84
2750	$6,137.48	0.45	$2.23	$2.32	$2.41	$2.50	$2.60
3000	$6,173.73	0.41	$2.06	$2.14	$2.22	$2.31	$2.39

[1.] Fixed Cost does not include a land charge. Subtract $.62, $.55, $.50, $.45, $.41 per Lb respectively in the table above to remove Fixed Costs at each yield level.

This budget was developed in Microsoft Excel and is available from your county Extension Office or online at: http://www.arec.vaes.vt.edu/southern-piedmont/farm-management/index.html .

AGRONOMIC INFORMATION

T. David Reed, Extension Agronomist, Tobacco

VARIETY SELECTION

Variety selection is an important decision for profitable production of flue-cured tobacco. Producing the highest possible yield of high quality tobacco is essential to profitability. However, many factors play a role in a grower obtaining the full potential of a variety. Foremost among these is a knowledge of the field history of each farm and selecting a variety or multiple varieties having the necessary disease resistance characteristics. When plant losses occur, it is important to confirm the actual cause in order to properly address the problem in later seasons. Additionally, the ease of curing and characteristics of the cured leaf are important considerations. Varieties differ in cured leaf color and other physical characteristics desired by purchasers (color, body, proportion of tip leaves, etc.), but these factors are also influenced by growing conditions and curing practices as well. In most cases, growers will need to choose more than one variety to grow to maximize their yield and address the requirements of individual field histories. Growers should carefully consider any dramatic change in varieties grown without first trying a new variety on a limited basis on their farm to get an ideal on how the variety will perform under their management practices.

Tobacco breeders continue to make progress in developing new varieties with improved resistance to the diseases that cause loss flue-cured tobacco. Detailed information on the disease resistance of flue-cured tobacco varieties is presented in the disease section of this production guide. It is especially important that growers have a correct identification of any diseases that may be causing field losses. Black shank, Granville wilt, and *Pythium* stalk rot may be confused and the presence of nematodes can make these and other root diseases more severe than expected or symptoms may not appear as expected. If past performance of a disease resistant variety has been less than anticipated, growers are encouraged to contact their local agriculture extension agent to investigate possible explanations and evaluate options. Proper identification of disease losses is essential to making the proper variety decision for the following season.

Although there are dozens of varieties available to flue-cured tobacco growers, perhaps as few as five account for more than 90% of the overall acreage in Virginia. The two most widely planted varieties in Virginia remain NC 196 and K 326 and this highlights the extremes that occur in field histories across our flue-cured tobacco producing area. NC 196 has been available since 2007 and has become the most widely planted flue-cured variety in the U.S. due to disease resistance levels and a reasonably

consistent high yield potential. K 326 (1983) remains a popular choice among growers with fields without a history of disease due to the high yield potential, curability, and holding ability of the variety. Other more popular varieties include: PVH 2310 (early maturity, good curing, low disease resistance), CC 143 (especially popular among organic growers needing black shank resistance and tolerance to the tobacco cyst nematode), and CC 37 (black shank and Granville wilt resistance plus added root knot nematode resistance).

Results from the 2022 Flue-Cured Tobacco Official Variety Trial conducted at the Southern Piedmont Center near Blackstone, Virginia are shown in Table 1. Data are shown for yield, grade index, and relative yield. Grade index is a numerical measure of tobacco quality allows for comparisons between varieties. Relative yield is calculated based on the overall average yield of all varieties in the test. A relative yield of 100 indicates a yield approximate to the overall average of the test while values of 104 or 96 indicate that the yield of a particular variety was 4 percent above or below the test average, respectively. The variety tests at Blackstone in 2022 produced good results for yield and quality given the range of growing conditions experienced. Late June through most of July was very dry and the tobacco was irrigated twice in July. Seven inches of rain fell the first week of August with some minor water damage in a few plots. This was followed by little additional rain through the middle of September. Overall yield was above that of the past few years and cured leaf quality was reasonable. The test was fertilized with a total of 65 pounds per ac of nitrogen and this was sufficient as harvest was completed in early October. The test site is free of soil-borne diseases and nematodes and thus the data reflect the yield potential in the absence of any disease losses. The incidence of foliar leaf spot diseases was minimal in 2022.

Relative yield data from the Flue-Cured Official Variety Trial for the past three seasons are presented in Table 2. The small number in parenthesis indicates the ranking of a specific variety among all of the varieties for each season. The test conducted at the Southern Piedmont Center is generally indicative of the yield potential of the different varieties grown under an irrigated, disease-free situation. A variety with a relative yield above consistently above 100 should be considered at having an above average yield potential.

Two new varieties will be commercially available for the 2022. Growers are encouraged to consider new varieties that may address needs (disease resistance, cured leaf characteristics, and yield) in their production. However, any new variety should initially be tried on a limited acreage to evaluate the variety under their specific conditions and management.

Table 1. Agronomic results from the 2022 Official Variety Trial conducted at Southern Piedmont Center - Blackstone, VA. New varieties are in bold.

Variety	Yield (lbs/ac)	Relative Yield	Grade Index
GL 365	3855	112	59
K 326	3836	112	68
GL 26H	3784	110	73
NC 196	3695	108	60
NC 71	3666	107	64
NC 960	3640	106	62
PVH 2254	3585	104	76
CC 145	3545	103	69
GF 318	3524	103	49
NC 291	3500	102	61
CC 37	3500	102	59
NC 1226	3489	102	56
CC 35	3457	101	55
PVH 1600	3444	100	65
CC 27	3442	100	69
PVH 2343	3442	100	72
GL 395	3427	100	60
CC 13	3421	100	74
NC 72	3420	100	61
GL 386	3413	99	75
CC 143	3401	99	72
CC 1063	3372	98	59
PVH 1920	3359	98	52
K 730	3326	97	70
CC 700	3309	96	69
NC 606	3297	96	78
PVH 2110	3261	95	72
PVH 2275	3239	94	64
NC 299	3222	94	66
CC 33	3211	94	62
CC 67	3209	94	46
PVH 2310	3077	90	66
K 346	2897	84	62
Test Average	3432		64

Table 2. Relative yields for Flue-Cured Tobacco Official Variety Trials conducted at the Southern Piedmont Center near Blackstone, Virginia for 2020 - 2022.

Variety	Relative Yield and Ranking within Year 2022	2021	2020	3-yr Avg. Relative Yield
GL 365	112 (1)	115 (7)		
K 326	112 (1)	118 (4)	101 (14)	110
GL 26H	110 (3)	114 (9)	105 (6))	110
NC 196	108 (4)	119 (2)	98 (22)	108
NC 71	107 (5)	116 (5)	110 (3)	111
NC 960	106 (6)	113 (9)		
PVH 2254	104 (7)	116 (5)	99 (20)	106
CC 145	103 (8)	109 (21)	90 (31)	100
GF 318	103 (8)	112 (11)	98 (22)	104
NC 291	102 (10)	107 (23)	101 (14)	103
CC 37	102 (10)	103 (28)	92 (29)	99
NC 1226	102 (10)	107 (23)	101 (14)	103
CC 35	101 (13)	110 (18)	117 (1)	109
PVH 1600	100 (14)	114 (7)	102 (11)	105
CC 27	100 (14)	110 (15)	113 (2)	108
PVH 2343	100 (14)	112 (11)	106 (5)	106
GL 395	100 (14)	108 (21)	94 (28)	101
CC 13	100 (14)	105 (27)	97 (24)	101
NC 72	100 (14)	104 (28)	99 (20)	101
GL 386	99 (20)	109 (18)	102 (11)	104
CC 143	99 (20)	119 (2)	105 (6)	108
CC 1063	98 (22)	107 (23)	95 (27)	100
PVH 1920	98 (23)			
PVH 1452		111 (13)	103 (9)	
K 730	97 (24)	100 (30)	90 (31)	96
CC 700	96 (25)	110 (15)	96 (26)	101
NC 606	96 (25)	95 (35)	90 (31)	94
NC 925		109 (18)	100 (17)	
PVH 2110	95 (27)	120 (1)	104 (8)	106
PVH 2275	94 (28)	100 (33)	103 (9)	99
NC 299	94 (28)	110 (15)	108 (4)	104
CC 33	94 (28)	102 (30)	91 (30)	95
CC 67	94 (28)	102 (30)	100 (17)	99
PVH 2310	90 (32)	111 (13)	100 (17)	100
K 346	84 (33)	99 (34)	90 (31)	91

GL 365 has been evaluated in our regional variety evaluation trials for a number of years. GL 365 has demonstrated a high level of resistance to black shank. The variety has the Php gene providing resistance to black shank Race 0 and the broad based, multi-gene resistance from FL 301 providing resistance to both Race 0 and 1. Additionally, GL 365 has a high level of resistance to bacterial wilt and resistance to the common root knot nematode. GL 365 will be marketed by Gold Leaf Seed Company.

NC 960 (tested as NC 1960) was developed by Dr. Ramsey Lewis at NCSU and has been released as a publicly available variety and thus seed will be commercially available from multiple sources. NC 960 is similar to the recently released NC 1226 with perhaps cured leaf color characteristics differing between the two. NC 960 has a superior black shank resistance due to the inclusion of the Php gene providing near immunity to race 0, partial multi-gene resistance to race 0 and 1 from FL 301 and the Wz gene as well. Although not consider to have a high level, NC 960 appears to have high level of resistance to bacterial wilt than NC 1226.

All varieties made available for sell to growers have been approved by the Minimum Standards Program conducted by the Regional Flue-Cured Tobacco Variety Evaluation Committee. This program is conducted to ensure that new varieties meet necessary chemical and physical characteristics as well as the smoking properties of the cured leaf. Growers are encouraged to visit varieties trials conducted each year both at the Southern Piedmont Center and on-farm with cooperating growers to view potential new varieties for their farm. Limited data are available regarding agronomic, traits, disease resistance, handling, and curing traits under a wide range of geographic conditions. Such information continues to be collected once a variety is made commercially available.

GREENHOUSE TRANSPLANT PRODUCTION

A successful tobacco crop begins with high quality transplants and the greenhouse float system remains the standard for the tobacco industry. Virtually all tobacco (flue-cured, burley, and dark-fired) transplants used in Virginia are produced in either a greenhouse or outdoor float bed.

Plastic Greenhouse Float Trays

The expanded polystyrene (EPS) float tray has been the foundation of the greenhouse float system that we currently use for tobacco. However, the continued use of EPS trays is a concern to the tobacco industry since EPS is not readily recycled, relatively difficult to dispose of in an environmentally sound manner, and represents a potential source of NTRM in cured tobacco. A more practical concern for growers is the cost and effectiveness of EPS tray sanitation. As EPS trays age they become more porous and greater root

penetration of the cells occurs. Such adds to the difficulty of removing contamination from the tray and reduces the effectiveness of tray sanitation.

A hard plastic float tray was introduced commercially to the tobacco industry in 2015 and enhancements made the following year to reduce the tray weight. A plastic tray addresses the environmental concerns of EPS trays and provides the grower with a tray that is easier to effectively sanitize and a tray with a substantially longer useful lifespan. The tray is compatible with most existing tray filling and seedling lines. Floatation of the trays comes from air trapped in multiple compartments on the underside of the trays. The trays have a lower floating depth resulting in increased media saturation, though seedling emergence is similar to that with EPS trays.

Greater attention to detail is warranted when clipping. Reel mowers need to be properly adjusted and blades sharpened to ensure a clean clipping of the plant foliage and avoid grabbing of the seedlings. Clipping height of both reel and rotary mowers should be adjusted to avoid pushing seedlings over with clipping. Excess space in float bays that allow movement of the trays when clipping is detrimental as well.

A trial was conducted in 2017 comparing EPS and the Trilogy plastic trays for initial plant stand (14 days after seeding) and usable transplants. Trays were evaluated with two soilless mixes, Beltwide and Carolina Choice. Additionally, trays were seeded with NC 938 to allow for comparison with two difference seed sources (Cross Creek and Rickard). Overall results showed a similar plant stand between the two trays and only a small difference in the percent usable transplants (89.6 and 87.5 % for EPS and plastic trays, respectively). Looking at the data for the tray types according to mix brand or seed sources illustrates the interaction of multiple factors on overall tray performance.

Table 3. Comparison of plant stand and usable transplants in EPS and Trilogy plastic float trays with two soilless mixes and seed sources.

Tray type	Plant Stand (14-days)	Usable transplants	Seedling mortality	Small seedlings
		---------- (%) ----------		
Beltwide mix and Cross Creek Seed				
EPS	94.6	88.6	2.8	3.2
Plastic	92.6	87.8	2.0	3.2
Beltwide mix and Rickard Seed				
EPS	94.6	91.8	2.0	0.6
Plastic	92.6	84.4	4.8	3.4
Carolina Choice mix and Cross Creek Seed				
EPS	91.0	87.2	1.0	2.8
Plastic	89.6	84.8	1.4	3.4
Carolina Choice mix and Rickard Seed				
EPS	95.2	90.8	2.0	2.8
Plastic	96.6	93.0	1.4	2.2
Rickard Seed averaged over overall mixes				
EPS	92.8	87.9	1.9	3.0
Plastic	91.1	86.3	1.7	3.3
Cross Creek Seed averaged over overall mixes				
EPS	94.8	91.3	2.0	1.7
Plastic	94.6	88.7	3.1	2.8
Beltwide mix averaged over seed sources				
EPS	94.5	90.2	2.4	1.9
Plastic	92.6	86.1	3.4	3.3
Carolina Choice mix averaged over seed sources				
EPS	93.1	89.3	1.5	2.8
Plastic	93.1	88.9	1.4	2.8
Averaged over both mix and seed source				
EPS	93.8	89.6	2.0	2.4
Plastic	92.9	87.5	2.4	3.1

Tobacco growers have become accustom to greenhouse management and the incidence of significant production problems that result in plant losses is unusual. Common production concerns include soilless mix issues, spiral root seedlings, fertilizer salts injury, algae growth, and various pest

occurrence. Greenhouse management practices described in this guide are intended to provide the basics for successful greenhouse production.

The occurrence of spiral root seedlings is always a concern but has generally declined in recent years as seed coatings have evolved to better match the requirements of the tobacco seed and the wetting properties of our commonly used greenhouses mixes. A spiral root seedling may occur when the emerging root tip is damaged and does not function properly to establish a young seedling. The single most important factor that a grower can do to reduce spiral roots is to avoid over packing of the soilless mix into trays. Such over packing will result in excessively wet media in the trays and this can often impact seedling emergence. In general, spiral root seedlings will be reduced when using an automatic tray filling line with a rolling dibbler. The goal is to fill trays as uniformly as possible. However, under the best of circumstances spiral root seedlings may occur due to seed related factors. Results of a greenhouse test in conducted in 2010 to compare the performance of three commercial seed lots of the one variety are shown in Table 4. All trays were filled and seeded in a similar manner. Spiral root seedling incidence ranged from 3 to 17% and closely matched observations of the same seed lots in grower greenhouses. The impact of the spiral roots was apparent in the percentage of usable transplants as well as small seedling and observed seedling mortality.

Table 4. Seed performance trial results of three commercial seed lots of one variety. Test was conducted at the Southern Piedmont Center in Spring 2010, Blackstone, Va. Data shown are averages of six replications.

Seed lot	14 dy seedling emergence	Spiral root seedlings	Usable transplants	Small seedling	Seedling mortality
	---------- (%) ----------				
A	93.1	17.1 a	75.9 b	13.5 a	4.9 a
B	93.1	3.3 b	84.9 a	6.8 b	1.4 b
C	91.0	10.3 a	79.0 ab	12.4 a	2.9 a

Results of this trial reinforce the observation that seed pellet factors still play a role in the incidence of spiral root seedlings. Previous research has shown that an average of one-third of these will survive to produce usable transplants, one-third will survive but are too small to transplant, and one-third will not survive.

The commonly used commercial soilless media used for tobacco transplant production are generally similar in their physical and chemical properties. When a problem does occur, it is not usually a common occurrence but limited to individual greenhouses or just a few. This would indicate that

something unusual has occurred with a relatively limited quantity of media. Such could occur during manufacture, transport, at the dealer, or on the farm. Although not common, problems can occur with excessively wet or dry mix, sticks or other debris impacting tray filling, and inadequate wetting chemical agents. Growers should always keep lot numbers from their greenhouse media in case a problem does occur. The use of old media should be avoided since the chemical wetting agent degrades over time and this can impact the amount and uniformity of media wetting in the trays (wicking). Media should be stored so to avoid excessively high temperatures and drying. Whenever possible, bags should be kept wrapped in plastic until seeding time to preserve proper condition. Water should not be added to bags of mix unless expressly directed by the manufacturer.

Algae growth on the media surface is a common occurrence and excessive growth that covers the seed can be a concern. Other than tray sanitation, there is actually very little growers can do to prevent algae growth and algae seldom has any significant impact on seedling growth. The best strategy is to provide conditions as favorable as possible for seed germination and early seedling growth. The intention is to allow for seedlings to grow as rapidly as possible and eventually shade out any algae growth.

Research Trial to Evaluate Timing of Initial Fertilization

Fertilizer salts injury can be a significant source of seedling mortality thus impacting the yield of useable transplants from a tobacco greenhouse. Mortality may occur when salt levels in the growing medium around a young seedling increase to a point where roots are burned and no longer able to provide adequate water uptake to the developing seedling. Float tobacco seedlings are most susceptible to injury during the third week after seeding and are seldom affected once roots have grown into the float bay water. Float production is more susceptible to accumulation of fertilizer salts than an overhead water system since water is continuing moving upward through the media and evaporating from the surface of the tray. The result is the accumulation of salts near the surface where the seedlings are emerging and developing. This accumulation is a natural occurrence in the float system and our goal as greenhouse managers is to maintain this below damaging levels. Factors that can lead to fertilizer salts injury include:

- A water source with high soluble salts – may require a delay in fertilizer addition or a reduced initial amount of fertilizer.
- Improper bay fertilization –such as too much fertilizer, or too early, or uneven distribution within the bays will increase fertilizer salts accumulation.
- Delayed or uneven seedling emergence – thus younger seedlings are exposed to increased salts level. Prolonged cloudy weather following seeding can delay germination or poor seed performance and subject seedlings to increased salt levels. Salts injury can

frequently be observed in trays along the side curtains where germination can be somewhat delayed due to cooler nighttime temperatures.

- Excessive air movement over the trays will contribute to increased water loss and salts accumulation. This can be especially apparent where horizontal airflow fans (HAF) or heater fans are blowing directly onto trays.

A study of the timing of fertilizer addition was conducted at the Virginia Tech Southern Piedmont Center in 2021. The study compared the addition of fertilizer at 1, 6, 11, and 16 days after seeding. The fertilizer used was a 16-5-16 and the initial fertilizer addition was 150 ppm N. Two different varieties were seeded with the intent to having differing seed performance and corresponding different levels of fertilizer salts injury. However, seed of both varieties exhibited excellent seedling emergence (early and uniform) and thus the data were combined as one. Data collected included: bay water Ec levels, media Ec levels, seedling emergence, seedling mortality, and final usable transplant counts. Electrical conductivity (Ec) is a measure of the soluble salts or fertilizer salts. The bay water Ec values of each treatment are shown in Figure 1a. The unfertilized Ec value of the bay water was less than 0.25 mS and the addition of the fertilizer is evident as an increase by more than 1.5 mS for each treatment following fertilizer addition to the bay water. The Ec of the soilless mix with the trays is the measure of the fertilizer salts exposure to the seedlings and this is shown in Figure 1b. The unfertilized Ec level was approximately 1.75 mS and the resulting impact of fertilizer addition can be seed for each treatment. Generally, an Ec value from a direct media extract of 3.0 to 3.5 mS at 14 days after seeding is a sign of potential fertilizer salts injury. The 1 DAS treatment exceeded 4.0 mS while the 6 and 11 DAS treatment peaked at 3.5 mS closer to 21 days after seeding.

The corresponding impact of fertilizer salts on the seedlings is shown in Table 5. Seedling stand or emergence at 14 days after seeding was quite high for these seed and was not impacted by fertilizer addition. However, the percent usable transplants were significantly reduced by early fertilizer addition at 1 DAS. Usable transplants were reduced to 86.4% by the earliest fertilizer addition, followed by 6 DAS at 91.9%. The loss of usable transplants occurred through early seedling mortality or seedlings too small to be transplanted. The number of dead seedlings corresponded to fertilizer timing, with 7.6% mortality with fertilizer added at 1 DAS.

Table 5. Results of greenhouse fertilization timing study conducted at the Southern Piedmont Center, 2021. Data shown are averages of 8 replications.

Timing of initial fertilization	14-day stand	Usable transplants	Seedling mortality	Small seedlings
	---------- (%) ----------			
1 DAS	96.5 a	86.4 a	7.6 a	2.5 b
6 DAS	65.4 a	91.9 b	2.1 b	1.4 ab
11 DAS	95.7 a	94.3 b	0.5 b	1.0 a
16 DAS	95.4 a	93.1 b	0.3 b	2.0 ab

Value within a column followed by the same letter are not significantly different

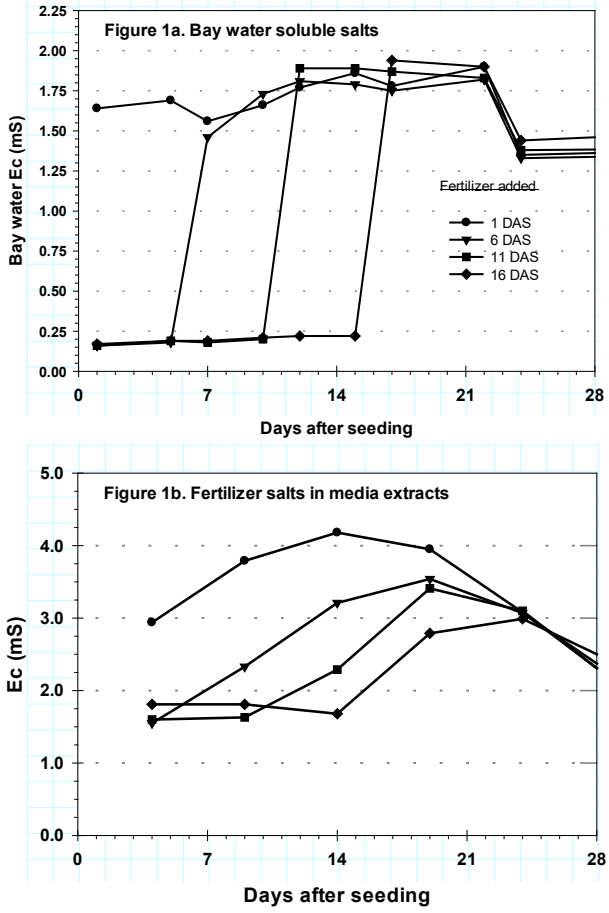


Figure 1. Bay water soluble salts (Fig. 1a) and fertilizer salts measured in media extracts (Fig. 1b) resulting from the addition of fertilizer to bays at 1, 6, 11, and 16 days after seeding (DAS). Test conducted at the Southern Piedmont Center, 2021.

Greenhouse Management Practices

The following is a brief description of the important management practices required for successful greenhouse production.

1. Sanitation
   Sanitation is the primary means of pest control available to greenhouse tobacco producers. Four important areas for sanitation include: the area in and around the greenhouse, people entering the greenhouse, float trays, and clipping equipment and the clipping operation. Specific information on sanitation is presented in the Disease Control chapter of this guide.

2. Ventilation and Air Circulation
   Ventilation is necessary to reduce to amount of moisture that naturally accumulates inside the greenhouse and to prevent the occurrence of enormously high temperatures. Brief openings of the side curtains early in the morning and in late afternoon are particularity effective in removing moisture laden air before condensation occurs. Air circulation within the greenhouse is beneficial to reduce temperature stratification, reduce condensation on the underside of the greenhouse cover, remove moisture from the plant canopy, and evenly distribute greenhouse gases. The use of horizontal airflow (HAF) or a polytube system is highly recommended to provide adequate air circulation.

3. Temperature Control
   The most demanding period for heating is during the seed germination period. Until optimum germination is obtained, the minimum temperature should be maintained at 70 to 72°F. Extended periods of cooler temperatures will delay germination and may decrease the uniformity in seedling emergence. Varieties differ somewhat in their temperature requirements. Providing some fluctuation in day to night temperatures is beneficial for some varieties and is seldom detrimental with others.

   After germination, the minimum temperature may be initially reduced to 60-65°F and later to 55°F. Preventing high temperatures is perhaps of even greater importance. Young seedlings are particularly sensitive and the temperature should not be allowed to reach 95°F during the 2- to 4-leaf stage. As seedlings grow they are better able to withstand increasingly higher temperatures. Although, to reduce stress on the seedlings, the temperature should not be allowed to exceed 100°F. High temperatures place greater stress on the tobacco seedlings due to increased water evaporation of and the resulting concentration of fertilizer salts on the surface of the growing medium.

   Avoid seeding too early to reduce the cost of greenhouse heating. High quality transplants can be grown in seven weeks in most situations;

though, some growers have found eight weeks may be necessary with 338-cell trays. An added benefit of not seeding too early is that some pest problems may be avoided by minimizing the time that plants are in the greenhouse. Many growers seed their greenhouse when labor or seeding equipment is available. If this occurs during a period of very cold weather, one may decide to provide only minimal heat (prevent freezing) for a few days until better weather conditions occur and less heating will be necessary. Research conducted for three years in Virginia has provided excellent results with providing for only a 40°F night time temperature and keeping the greenhouse cool during the day (open) for a period of three to five days. This allows for seed pellets to soften without beginning seed germination. Afterwards, normal heating can be started. This has been especially beneficial in reducing spiral root seedlings.

Greenhouse temperatures should be measured at plant level in one or more locations that are representation of the entire greenhouse. The use of a recording thermometer to measure daily high and low temperatures is an excellent management practice. Thermostat settings for heating and cooling should be made of the basis of thermometers within the immediate environment of the plants.

4. Media and Tray Filling

Media and tray filling may be the source of the greatest number of problems for Virginia greenhouse tobacco producers in recent years. Dry cells and spiral roots are each related to media and the tray filling operation. Assuring that all cells within a tray are uniformly filled and that all trays are similar will improve the uniformity in seed germination and seedling growth. Cells must be completed filled for their entire depth to wick properly and prevent dry cells; but over packing of the cells must be avoided to prevent the occurrence of spiral root plants. Proper moisture content of the mix is critical for adequate tray filling and the use of a premoistened medium is highly recommended. Better plant stands are generally obtained with a mix having a dry consistency rather than a mix with increased moisture and thus a heavier consistency. The mix needs only enough moisture to keep it from falling through the trays before floating. If trays wick properly, watering over the top should not be necessary to assist with seed germination. However, if trays are watered, only a fine mist should be used to prevent packing and waterlogging of the medium.

5. Fertilization

Fertilizers used in float greenhouse transplant production are formulated to function with a soilless growing medium. Such fertilizers should contain at least 50 percent of their nitrogen as nitrate-N and should contain only a minimal amount of urea. Also important to

proper fertilization is an accurate estimation of fertilizer solution concentration. In addition to using the correct fertilizer material, proper fertilization requires an accurate estimation of fertilizer solution concentration to ensure that seedlings are not injured by excessive fertilizer salts. The amount of fertilizer necessary for a float bay is determined by the volume of water in a bay, the fertilizer analysis, and the desired nutrient level of the float bay. Additional information on fertilization is presented on page 19.

6. Water Quality
   Water quality is a critical factor to consider with greenhouse production. Although water sources across the flue-cured tobacco producing area of Virginia pose little difficulty for most growers, scattered cases of water quality problems have occurred for some growers. The only means of predicting such problems is through water testing. When having water analyzed it is important to have the results interpreted for plant production properties rather than as drinking water.

7. Clipping
   Clipping is an essential management practice for direct-seeded greenhouse tobacco production. Begin clipping when plants are at least 2 inches to the bud. If seedling growth is unusually uneven, earlier clipping will allow smaller plants to catch up. Research conducted in Virginia indicates that the timing of the first clipping, the severity of clipping, and the number of total clippings does not have a significant impact on the stem diameter of the transplants. However, the above factors were important in controlling the growth rate of the seedlings and the size of the field-ready transplant. Very early clipping (1.5 inches to bud or less) resulted in shorter than desired transplants.

Suggested Clipping Program

- Begin clipping when plants are 2 to 2.5 inches tall (bud height)
- Set mower blade at 1 to 1.5 inches above bud
- Clip on a 3-day interval between the first 3 clipping dates and every 5 days thereafter

Plant clippings must be collected to reduce the likelihood of disease development and spread throughout the entire greenhouse. The mower used to clip plants should be thoroughly cleaned and sanitized with a 50% chlorine bleach solution following each use.

The above description of greenhouse tobacco transplant production is greatly abbreviated. Additional information is available from your local Extension agent and is detailed in a “Float Greenhouse Tobacco Transplant Production Guide”, VCE Publication No. 436-051.

Float Fertilization Programs

The suggested fertilization schedule for greenhouse tobacco transplant production has been changed for recent seasons. This is the result of research trials conducted the past year and extensive observation of grower greenhouses over the past several years. Such a change was warranted due to the relatively high fertilizer charge of the brands of greenhouse mixes that have gained in popularity in recent years. Furthermore, some of the newer, popular flue-cured tobacco varieties have a tendency for slow and uneven seedling emergence making them more subject to injury from fertilizer salts. The new suggested fertilizer program is intended to reduce the potential of excessive fertilizer salts build-up while not impacting early seedling growth.

Suggested Greenhouse Tobacco Fertilization Schedule

1. Add 150 ppm N 3 to 5 days after seeding
2. Maintain water level at 75% of the original depth for the first 3 weeks
3. Refill bays to original depth and add 100 ppm N at 4 weeks after seeding in preparation for initial clipping

Though seedling injury or mortality is not necessarily common, the most likely timing for the occurrence is during the third week after seedling before root grow into the water. A potential cause can be avoided by not allowing the bay water levels to fall below 75% of the original depth during the first 3 weeks after seeding thus not allowing the fertilizer to become concentrated.

The total of both applications is the equivalent of 250 ppm N based on the original depth of water in the bay (usually 4 inches). For example: using a 16-5-16 fertilizer, a total of 20.8 oz per 100 gal. (250 ppm N) would be needed with 12.5 oz per 100 gal. (150 ppm N) for the first application and 8.3 oz per 100 gal. (100 ppm N) for the second. Under normal conditions, no additional fertilizer beyond the total of 250 ppm N should be necessary. However, if the greenhouse season is prolonged due to early seeding or late transplanting, a late season addition of 75 to 100 ppm N may be needed to maintain adequate seedling nutrient levels.

The primary drawback of delaying fertilization until after the trays are floated is the difficulty in adequately mixing the fertilizer throughout the entire float bay. To insure even mixing of fertilizer throughout the float bay: dissolve fertilizer in buckets of water, add fertilizer at several locations throughout the bay, and use pumps to circulate water and distribute the

fertilizer throughout the bay. Handheld conductivity meters (e.g. DiST4 or TDR Tester 4) are excellent tools to verify that fertilizer is evenly mixed throughout the entire float bay and that the desired concentration is obtained. The nutrient solution should be checked in several locations along both the center walkway and side curtains.

Growers accustom to using fertilizer injectors can continue to do so with the above fertilizer schedule. The most practical method would be to add fertilizer to the bay 1 to 3 days after seeding with adequate mixing in the bay water. The injector would be used to add 125 ppm N with each later addition of water to the bay. An alternative would be to fill bays to initial depth of 2 in. and allow trays to wick. The following day, bays would be filled to a depth of 4 in. injecting a 300 ppm N fertilizer solution for a final concentration of 150 ppm in the bay. Later additions of water would contain a concentration of 125 ppm N through the injector.

Calculation of Water Volume and Fertilizer Concentration

1. The number of gallons of water in a float bay may be calculated by:

$$\text{length (ft)} \times \text{width (ft)} \times \frac{\text{depth (in)}}{12} \times 7.48 \text{ gal/ft}^3$$

***Example**:* $96 \text{ ft} \times 16 \text{ ft} \times \frac{4 \text{ in}}{12} \times 7.48 = 3829 \text{ gal}$

2. The amount of fertilizer required per 100 gal of water is calculated by:

$$\frac{\text{desired nutrient concentration (ppm)} \times 1.33}{\text{nutrient content of fertilizer (\%)}}$$

Example: $\frac{150 \text{ ppm N}}{16\% \text{ N}} \times 1.33 = 12.5 \text{ oz per } 100 \text{ gal}$

Organic Greenhouse Transplant Fertilization

Organic greenhouse fertilization is substantially more difficult than with a conventional greenhouse since organic fertilizers are not highly water soluble and the nitrogen is not readily available to the plants. Seabird guano (typically 12-10-2) is the most commonly used product and is predominately urea and contains very little plant available nitrate-N. Therefore, the N must be converted from urea to ammonium and then nitrate through natural processes that occur with variable rates in the anaerobic conditions present in greenhouse float bays. Seabird guano pellets are especially slow to dissolve so the process can be hastened by grinding the pellets to a powder and by soaking pellets in buckets of water to make a tea than can be periodically poured off into the float bay. To overcome the detrimental effects of anaerobic conditions in float bays, research has been conducted to evaluate the aeration of bays to added oxygen to the water. Results have

shown benefits of doing so by a practical means of effectively aerating large bays has not be determined.

Research conducted at North Carolina State University has provided two suggested organic greenhouse fertilization programs.

Program 1:

- 13.9 oz per 100 gal.seabird guano (12-11-2)
- 3.0 oz per 100 gal potassium sulfate (0-0-52)

Program 2:

- 4.9 oz per 100 gal.seabird guano (12-11-2)
- 6.8 oz per 100 gal sodium nitrate (16-0-0)
- 3.0 oz per 100 galpotassium sulfate (0-0-52)

The fertilizer should be added to the bays in spilt applications approximately 1 and 3 weeks after seeding. Seabird guano is relatively high in phorphorus and can result in relatively spindly seedlings. Program 2 addresses this by supplying the majority of the nitrogen from sodium nitrate which is readily available to the plants and does not contain any phosphorus.

Usable Greenhouse Transplant Yield Research

The impact of seed, media, and fertilization on the yield of usable transplants was investigated in research trials conducted on-farm and at the Southern Piedmont Center. The timing of initial float bay fertilization (150 ppm N) was found to have the greatest impact on usable transplants. Fertilization at seeding resulted in an average seedling mortality of 15% compared to 6% where fertilizer was added three days after seeding. Delaying fertilizer addition until after seeding and floating of the trays resulted in 5 to 15% more usable transplants, depending on the particular seed and media combination. The primary benefit of adding fertilizer after trays are initially floated is to minimize the accumulation of excessive fertilizer salts in the media. Seedling mortality observed during the third week after seeding is frequently a result of excessive fertilizer salts. Fertilization was not found to impact the occurrence of spiral root seedlings. Seed, media, and the interaction of these two factors were related to the account of spiral root seedlings.

FERTILIZATION

The basic principles of flue-cured tobacco fertilization have been established by decades of research, but the subject has received much greater attention in recent years due to dramatic increases in the cost of fertilizer. Such increases in cost have provided growers with greater reason to examine their overall soil fertility program and how they fertilizer their tobacco. Any soil fertility program should begin with soil testing. Lime should be applied

according to soil test recommendations. The amounts of phosphorus (P_2O_5) and potash (K_2O) fertilizer should follow soil test levels.

A cost effective tobacco fertilization program begins with the selection of the complete grade fertilizer product based on soil P levels. Phosphorus contributes greatly the cost of fertilizer, and therefore; the lowest P grade fertilizer product to meet the soil test recommendation should be the most economical. Fields with a history of tobacco will usually tests at a medium plus (M+) to high level for soil P due to past applications of high P fertilizer products. Over application of P will not improve crop performance, but will continue to build-up high soil P levels and potentially contribute to environmental contamination through soil runoff into watersheds. Historically, the tobacco grade fertilizer with the lowest P level has been a 6-6-18 product.

The choice of a sidedress fertilizer product should be based on whether additional potash is needed above that supplied in the complete fertilizer application. Historically this was a choice primarily between 16-0-0 nitrate of soda and 15-0-14 soda potash. However, the availability of both of these products has been sporadic in recent years but alternative products have been introduced. Below is a list of tobacco sidedress products expected to be available next season.

Common Tobacco Sidedress Fertilizer Products

	Percent (%) nitrate-N
15.5-0-0 (calcium nitrate)	100
15-0-2 (predominately nitrate of soda)	100
13-0-14 (blended product)	~25
12-0-46 (predominately potassium nitrate)	100
Liquid products	
CN-9 (liquid calcium nitrate)	100
UAN-30 (liquid urea ammonium nitrate solution)	25

The above materials were evaluated in 2017 in a sidedress fertilizer trial at the Southern Piedmont Center. The potash recommendation for test site was 120 lbs per ac and this was supplied with an application of 700 lbs per ac of 6-6-18 at bedding. Sidedress products were applied at rates necessary to

provide 40 lbs per ac of N and therefore sidedress potash rates ranged from 0 to 153 lbs per ac depending on the sidedress product. No significant differences were observed for either yield or cured leaf quality.

Sidedress products with all nitrate N would be expected to result in quicker uptake and response in the crop. Application of liquid sidedress products such as CN-9 and UAN are convenient in application and save time in handling materials although specialized equipment is necessary. To reduce potential loss of N through volatilization, shallow incorporation of UAN is suggested. Sidedress products should be applied by the third week after transplanting to ensure for adequate uptake by the plants and proper crop maturation.

Tobacco Fertilizers

Historically, complete tobacco fertilizers (NPK) have been formulated to supply at least 50% of the total N as nitrate-N. Doing so ensures a more precise availability of the nitrogen to the plant, regardless of soil and environmental conditions. However, due to the cost and availability of basic fertilizer ingredients, tobacco fertilizers containing only 25% nitrate-N have been marketed in recent years. Research in Virginia with tobacco fertilizers with 50, 25, and 0% nitrate-N has not shown the reduced nitrate-N content to have a significant impact on either yield or quality of the cured tobacco. If the lower nitrate-N content is a concern, growers still have the option of using an all nitrate-N sidedress product to minimize the total amount of ammonium-N applied to the crop. Ammonium-N is naturally converted to nitrate-N for uptake by the plant. Therefore, application of a 25% nitrate-N fertilizer should not be excessively delayed beyond transplanting.

Tobacco fertilizers have traditionally been ammoniated products where the basic ingredients are melted and mixed to produce individual fertilizer granules that are as uniform in their content as possible. Another cost saving measure has been the use of blended tobacco grade fertilizer products. Blending produces a product that is as uniform a mixture of different fertilizer sources as possible. The quality of any blended fertilizer is dependent on the capacity of the fertilizer blender to provide a uniform product.

The practice of blending a complete fertilizer (NPK) with a sidedress fertilizer and working a single application is discouraged. Blending two dissimilar fertilizer products can result in a lack of uniformity. Furthermore, a single early application of fertilizer subjects all to potentially leaching rains and makes any necessary adjustment more difficult. Split application of a complete fertilizer and a sidedresser provides the nutrients to the cop when they are needed and the grower has greater control over the availability.

A third traditional property of tobacco grade fertilizers is a limitation on chlorine or muriatic sources (potassium chloride). Chlorine is a factor that impacts the chemical quality of the tobacco by affecting the burn rate of tobacco as well as the curability of air-cured tobacco types. This remains an important issue to the industry and growers must not try to save on fertilizer expense by using fertilizer products containing excessive chlorine.

Soil Testing

Only through soil sampling and soil testing can the pH and nutrient status of soils be determined and the most cost effective fertilization program followed. Fields used for tobacco production should be soil sampled every three years to monitor changes in soil pH. Soil testing and liming according to recommendations are critical to avoid either a low pH situation or an excessively high pH that results from over liming. Overliming can increase the possibility of certain disease problems (black shank and black root rot) and cause an imbalance of certain micronutrients; *though this should not be considered as a justification for not liming according to soil test recommendations*. The most common soil fertility problem associated with tobacco production in Virginia is low pH. As soil pH falls below 5.0, the availability of most soil nutrients may become limiting and elements such as manganese and aluminum can become toxic to tobacco. Furthermore, the efficiency of applied fertilizers is reduced by low soil pH as shown below. Fertilizer efficiency is considered to be optimum at a pH of 7.0; though this pH is not considered optimal for tobacco. The desired pH range for flue-cured tobacco is 5.7 to 6.2.

	Fertilizer Efficiency		
Soil pH	**Nitrogen**	**Phosphate**	**Potash**
7.0	100%	100%	100%
6.0	**89%**	**52%**	**100%**
5.5	77%	48%	77%
5.0	**53%**	**34%**	**52%**
4.5	30%	23%	33%

Failure to maintain a soil pH within the desirable range of 5.7 to 6.2 results in reduced fertilizer efficiency and perhaps increased fertilizer costs due to the over application of fertilizer necessary to compensate for reduced nutrient availability.

Nitrogen

Tobacco plant development, and more importantly leaf ripening, are directly affected by the availability of soil nitrogen. The cropping history and rotations of most typical tobacco fields precludes little carryover of nitrogen to be available to tobacco. As a result, the N requirement for flue-cured tobacco is supplied primarily through chemical fertilizers. Control of the amount and timing of N directly impacts the ripening and the curability of flue-cured tobacco. Inadequate N results in both low yield and quality as the plant does not develop and mature properly. However, the application of too much N is more likely to occur. Excessive N delays ripening and is associated with tobacco that is undesirable in color (KL, KF, GK, etc.), high in nicotine, and is of generally poor quality. Harvesting unripe tobacco affects curing costs by lengthening the yellowing time and thereby delays the turnaround time for curing barns. Excessive nitrogen may have secondary effects on the cost of production by increasing sucker growth as well as the susceptibility or severity of the crop to late season insect pests and disease outbreaks.

There is no reliable soil testing procedure for determining nitrogen needs as there is for phosphorus, potassium, and other nutrients. It is well recognized that soils differ in their ability to hold nitrogen. Some of the more important soil characteristics affecting N availability are organic matter content, soil texture, and depth to subsoil. Previous cropping history, seasonal rainfall, and variety must also be considered in determining nitrogen rates. Fields with deeper, sandy topsoils require more nitrogen than those with shallower, heavier textured topsoils. For sandy loams soils of average fertility, suggested nitrogen rates for different topsoil depth are as follows:

Topsoil depth (in.)	**Nitrogen rate (lbs/ac)**
0 to 12	50 to 60
12 to 18	60 to 70
18 to 24	70 to 80

Adjustment for Leaching

Leaching is the loss of certain nutrients as a result of excessive water moving (percolating) through the root zone. Many producers often confuse drowning and associated root damage with fertilizer leaching. Leaching is seldom a problem on heavier textured soils or on soils with a hardpan within 10 to 12 inches of the surface. It is not uncommon for nitrogen and potassium to move down to clay and then be absorbed later as root growth

continues. Adjustment for leaching in this case usually results in over fertilization and a crop that is slow to mature and difficult to cure.

When leaching does occur, the reapplication of both nitrogen and potassium may be necessary. The quantity of nitrogen and potassium required will depend on the amount of water that percolates through the plow layer and the stage of plant growth at the time this occurs. Although research information on nutrient replacement from leaching is limited, the information in Table 6 (taken from N. C. Agric. Ext. Serv. Pub. AG-187) may be used as a general guide for making leaching adjustments.

Table 6. Nitrogen Adjustment for Excess Water[a]

Topsoil depth (to clay) (in.)	Estimate amount of water percolated through soil (in.)[b]	% of applied N to replace after transplanting ----------weeks---------- 1 to 3	4 to 5	6 to 7
Less than 10	1	0	0	0
	2	20	10	0
	3 or more	30	20	0
10 to 6	1	30	20	0
	2	45	30	10
	3 or more	60	40	15
17 or more	1	50	25	15
	2	75	35	20
	3 or more	100	45	25

[a]For each lb. of N used as an adjustment for leaching, use about 1 lb. of potash (K_20) where recommended potash levels as a base application have been used.
[b]Excess water is that quantity percolating through the soil after the water-holding capacity of the soil has been satisfied.

Applications of fertilizer to replace nutrients lost through leaching should be made as soon as possible after leaching rains occur. Waiting until deficiency symptoms develop in the crop before applying supplemental fertilizer will decrease the likelihood of a positive response to the fertilizer.

Phosphorus and Potassium

Phosphorus is probably the nutrient used more excessively in tobacco fertilization in Virginia. Repeated applications of larger quantities of phosphorus than plants can absorb, and with essentially no loss from leaching, has resulted in a general buildup of this nutrient. Soil analyses of tobacco fields conducted by the Virginia Tech Soil Testing Laboratory indicated that approximately 97% of the soils had a medium or higher

phosphorus level. Extensive testing in Virginia and other states has shown that on soils with a medium or high phosphorus level, 40 pounds of phosphorus ($P_2 0_5$) per acre are adequate to give maximum production and maintain the soil phosphorus levels. Growth responses of tobacco to phosphorus application are observed more frequently early in the growing season than they are in final yield and quality.

Potassium requirements of tobacco are relatively high, and a high potassium content in flue-cured tobacco impacts acceptable smoking characteristics of the tobacco. Soils vary in their supply of available potassium, depending upon the parent material, previous fertilization, and cropping history. Approximately 100-175 pounds of potash ($K_2 0$) per acre are adequate for most soil conditions. Potassium may be lost by leaching from the root zone in extremely sandy soils.

Due to the many factors necessary to consider when making fertilizer recommendations for a particular field, data in the following table can be used only as general recommendations for phosphorus ($P_2 0_5$) and potassium ($K_2 0$).

Soil Test Category	Pounds suggested per acre	
	$P_2 0_5$	$K_2 0$
L	230*	150-175
	60-100	
M	60-100	100-150
H	40	100
VH	40	100

*Basic application; to build up soil phosphorus may be broadcast and plowed-in or disked-in before planting. The 230 lb $P_2 0_5$/A can be obtained from 500 lb/A of 0-46-0.

Calcium and Magnesium

If the soil pH is maintained within the desirable range of 5.7 to 6.2 with dolomitic limestone, the available levels of calcium and magnesium will generally be sufficient to meet the needs of the crop. Otherwise, 40 to 50 lb/A of Ca and about 30 lb/A of available magnesium oxide (MgO) are needed from the mixed fertilizer.

Micronutrients

The need for the application of micronutrients such as boron, copper, manganese, and zinc has not been demonstrated sufficiently with tobacco to warrant general applications. It is definitely known that if applied at

excessive rates, these elements are toxic to tobacco. Though not likely to occur, boron is the micronutrient most likely to be deficient for tobacco. Generally, 0.25 pound of elemental boron per acre (approximately 2.5 pounds of borax) is sufficient to correct or prevent such deficiencies.

Transplant Starter Solutions

The benefit of a high phosphorus starter fertilizer in the transplant setter water results from the ready availability of P at the stage in crop development when the nutrient be most limiting. Transplant starter fertilizers should contain a greater proportion of P_2O_5 than N and potash (i.e. 10-52-8, 9-45-16, 12-48-8, etc.) and research has shown a rate of 4.5 to 5 lbs P_2O_5 per acre to be sufficient and not result in crop injury. The use of high P transplant starter fertilizer can be expected to provide more rapid and uniform early season growth. Such can be beneficial when cultivating and will most likely result in earlier, and more uniform topping. However, these effects do not persist through harvest and no yield response should be expected. The results of a comparison of transplant starter fertilizers are described in tables below. The test evaluated starter fertilizers using both plant bed and greenhouse-grown transplants. Treatments tested included:

Trt. No.	Product	Analysis	Application rate
1	Untreated	--	--
2	Exceed	10-10-10	2 qts/a
3	Jump-Start	8-31-4	2 qts/a
4	Charge	8-32-5	2 qts/a
5	Pro-Sol	10-52-8	10 lbs/a
6	Miller	12-48-8	10 lbs/a

The products tested differ in analysis (N:P:K) and no attempt was made to apply similar nutrient levels with each product. Products were applied at suggested rates; and therefore, nutrient levels are not equal among the treatments.

Measurement of plants in the field indicated that Trts. 3 - 6 (high P) resulted in more rapid early season growth than observed with the low P fertilizer (Trt. 2) or untreated plants (Trt. 1). As plants neared topping stage, differences between the treatments tended to diminish. However, plants in Trts. 3 - 6 did come into top earlier than those in Trts. 1 and 2. There was no apparent difference in the response of plant bed and greenhouse-grown transplants to the fertilizers. Such early season growth responses did not result in any significant difference in the yield of the treatments for both plant bed and greenhouse transplants (see Table 7).

Table 7. Topping and yield data for six transplant water treatments applied to plant bed and greenhouse float transplants, Southern Piedmont AREC, 1993.

Starter fertilizer	Percent of plants topped by July 19		Yield (lbs/a)	
	GH	PB	GH	PB
Untreated	33	30	3456	3471
Exceed	23	30	3365	3400
Jump-Start	69	88	3094	3424
Charge	59	64	3440	3525
Pro-Sol	81	88	3122	3399
Miller	86	59	3169	3356

GH = greenhouse and PB = plant bed grown transplants

Fertilizer Calculations

(1) Calculating nutrient rates

A **6-6-18** fertilizer is **6%** N, **6%** P_2O_5, and **18%** K_2O (potash)

Example:

700 lbs/ac of 6-3-18 would supply:

42 lbs/ac N or 700 lbs/ac x 0.06 N

42 lbs/ac P_2O_5 or 700 lbs/ac x 0.03 P_2O_5

126 lbs/ac K_2O or 700 lbs/ac x 0.18 K_2O

(2) Calculating fertilizer rate to obtain a desired nutrient rate

Example:

30 lbs/ac N from 15.5-0-0 (calcium nitrate) would be supplied by:

$$194 \text{ lbs/ac} \quad \text{or} \quad \frac{30 \text{ lbs/ac N}}{0.155 \text{ N}}$$

DE-LUGGING OF FLUE-CURED TOBACCO

The demand for high quality U.S. tobacco remains strong in the world market. However, this is tempered somewhat by changes in recent market seasons toward specific styles of cured leaf and weaker market demand for otherwise high quality tobacco grades deemed undesirable by some contract companies. Quality upper stalk tobacco that is not orange to mahogany can be significantly discounted by some buyers. Additionally, thin-bodied grades of tobacco (lugs and cutters) has become increasing difficult to market due the comparatively high price of this style of tobacco in the world

market. Such tobacco is in an oversupply from numerous sources worldwide and the price of U.S. tobacco creates a severe competitive disadvantage. As a result, some contract purchasers of U.S. tobacco have either limited purchases of thin-bodied tobacco or substantially discounted the prices for such tobacco.

The practice of removing of lower leaves and discarding is described as "de-lugging" and has been discussed within the industry from time to time given the supply and demand for lug and even cutter grades of tobacco in the world market. Research evaluating de-lugging management practices has been conducted in multiple countries as the oversupply of thin-bodied tobacco is not limited to the U.S. De-lugging studies have been conducted in Virginia the past two seasons. Factors studied included: (1) the number and timing of lower leaf removal, (2) topping higher to compensate for removal of lower leaves, and (3) the addition of extra nitrogen to replace that lost in the early removal of leaves from the plant. A description of four de-lugging studies conducted at the Virginia Tech Southern Piedmont Center in 2017 are described below.

Field Research Tests

1. Timing and number of removed for de-lugging
   - Timing of leaf removal: layby, topping, and time of normal first harvest
   - Number of leaves removed at de-lugging: 4, 6 and 8 leaves
2. De-lugging leaf number and topping height
   - Number of leaves removed at de-lugging: 4, 6 and 8 leaves
   - Topping height: normal (18-20 leaves), plus 2, and plus 4 leaves
   - All de-lugging occurred at topping time
3. De-lugging timing and added nitrogen sidedress
   - Timing of leaf removal: layby, topping, and time of normal first harvest
   - Extra N sidedress: 0, 5, and 10 lbs per ac
   - Number of leaves removed was 4.
4. Topping height and added nitrogen sidedress
   - Topping height: normal (18-20 leaves), plus 2, and plus 4 leaves
   - Extra N sidedress: 0, 5, and 10 lbs per ac
   - All de-lugging occurred at topping time
   - Number of leaves removed was 4.

All four tests were planted with NC 196. Standard fertilization for all of the above tests was 72 lbs per ac of N supplied from 700 lbs of 6-6-18 and 195 lbs of 15.5-0-0. Additional N treatments were supplied from 15-0-2.

Results of the limited research conducted shows clearly the yield loss expected with the de-lugging treatments. This yield loss can be reduced by de-lugging earlier (at layby compared to topping or later) before the plants directs additional resources to the leaves and giving the plant additional time to compensate for leaf removal. Removal of 4 leaves eliminated lug (X) grades in these studies while cutters (C) were eliminated by only 6 and 8-leaf removal. However, results for an individual grower will depend on harvest management practices such as the number of leaves in the first harvest and the total number of harvests. Although results are not conclusive, topping higher to make-up for de-lugging yield loss dues appear to be effective. However, it should be noted that topping higher will impact crop maturity and ripening and should be considered carefully on an individual farm basis. Perhaps the most prudent approach would be to evaluate this on your farm and to try topping two leaves higher initially. The additional of added nitrogen (5 or 10 lbs per ac) did not result in increased yield and is therefore not recommended.

De-lugging Study no. 1. Average yields (lbs per ac) of de-lugging treatments evaluating the timing and number of leaves removed. The percent reduction in yield compared the standard treatment is shown below each average yield in parentheses.

Yield of standard management treatment = 2829 lbs per ac

Timing of de-lugging treatment	Number of leaves removed with de-lugging		
	4	**6**	**8**
Layby	**2692** (4.8%)	**2326*** (17.8%)	**2255*** (20.3%)
Topping	**2598** (8.2%)	**2251*** (20.4%)	**1955*** (30.9%)
At first harvest	**2268*** (19.8%)	**2289*** (19.1%)	**2016*** (28.7%)

Yields highlighted with a '*' are significantly different from the standard treatment.

De-lugging Study no. 2. Average yields (lbs per ac) of de-lugging treatments evaluating the number of leaves removed and topping height. De-lugging of four leaves occurred at topping time. The percent reduction in yield compared the standard treatment is shown below each average yield in parentheses.

Yield of standard management treatment = 2761 lbs per ac

Added topping heights (leaves)	Number of leaves removed with de-lugging		
	4	**6**	**8**
normal	**2208*** (20.0%)	**2075*** (24.8%)	**1649*** (40.3%)
Plus 2	**2492** (9.7%)	**2163*** (21.7%)	**1887*** (31.7%)
Plus 4	**2591** (6.2%)	**2235** (19.1%)	**2311** (16.3%)

Yields highlighted with a '*' are significantly different from the standard treatment.

De-lugging Study no. 3. Average yields (lbs per ac) of de-lugging treatments evaluating the timing and extra N fertilization. The percent reduction in yield compared the standard treatment is shown below each average yield in parentheses.

Yield of standard management treatment = 2966 lbs per ac

Timing of de-lugging treatment	Added N sidedress (lbs per ac)		
	0	**5**	**10**
Layby	**2725** (8.1%)	**2675** (9.8%)	**2718** (8.4%)
Topping	**2471*** (16.7%)	**2409*** (18.8%)	**2657*** (10.4%)
At first harvest	**2351*** (20.7%)	**2393*** (19.3%)	**2303*** (22.4%)

Yields highlighted with a '*' are significantly different from the standard treatment.

De-lugging Study no. 4. Average yields (lbs per ac) of de-lugging treatments evaluating topping height and extra N fertilization. De-lugging of four leaves occurred at topping time. The percent reduction in yield compared the standard treatment is shown below each average yield in parentheses.

Yield of standard management treatment = 2784 lbs per ac

Added topping heights (leaves)	Added N sidedress (lbs per ac)		
	0	**5**	**10**
normal	**2482*** (10.8%)	**2271*** (18.4%)	**2475*** (11.1%)
Plus 2	**2682** (3.7%)	**2629** (5.6%)	**2722** (2.2%)
Plus 4	**2683** (3.6%)	**2791** (+0.3%)	**2769** (0.5%)

Yields highlighted with a '*' are significantly different from the standard treatment.

SUCKER CONTROL

Flue-cured tobacco should be topped when 40 to 50 percent of the plants reach the elongated button stage of flowering. Remaining plants should be topped as early as practical reaching the button stage. Allowing tobacco to remain untopped for up to three weeks after reaching the button stage will reduce yields 20 to 25 lb per acre per day. Late topping increases the number of pretopping suckers that must be removed as well as the chance of plants blowing over in a windstorm.

The height at which to top the plants will depend primarily on seasonal conditions, variety, and, to some extent, on the fertility level of the soil. Optimum leaf number is generally in the range of 18 to 22 leaves per plant.

MH Residues

Residues of MH have long been a concern for the tobacco industry and this factor is especially critical for tobacco sold for international markets. Virginia has historically had some of the lowest MH residues levels of any tobacco grown in the U.S. This has largely been due to the hand application of flumetralin products such as Drexalin Plus, Flupro, and Prime+. However, this is a more labor intensive procedure and worker safety is a

significant concern. Growers need to be mindful of product signal words and the required personal protection equipment for each.

Residues of MH remain an industry concern and Virginia is generally among the lowest in MH. However, growers are evaluated individually in regard to MH residues and must follow recommended practices to decrease the likelihood of residues becoming an issue.

Guidelines to Minimize MH Residues

1. Observe the preharvest interval (PHI) of 7 days following MH application. Rainfall during the preharvest interval is helpful in reducing MH residues. Additional time beyond the PHI will further reduce the likelihood of excessive MH residues.

2. Make only 1 application of a labeled rate of MH. Do not make split applications of MH even at reduced rates since the second application will likely increase residues present in later harvests.

3. Consider the addition of flumetralin to a sequential sucker control program. These products may be tankmixed with MH, applied before the first harvest and delaying MH, or applied alone after MH (usually 3 to 4 weeks later).

   The application MH after first harvest should not exceed 1 gal per ac. (1.5 lbs a.i.) and should be made as soon as possible after the harvest.

4. Maximize the effectiveness of contact fatty alcohols by limiting excessive growth prior to their application. It is important to make the first application before pre-topping suckers have grown too large (greater than 1 in. long). The first application of a C8 / C10 fatty alcohol mixture should be made at a 4% concentration (4 gal. to 96 gal. of water) and later applications should be made at 5% (5 gal. per 95 gal.).

5. The use of coarse spray tips (i.e. TG3-TG5-TG3) and low pressure for MH applications results in coarser droplets that result in less wetting of the underside of the leaves and thus not as exposed to rainfall and dews.

6. Make certain of the concentration of your MH product as formulations may contain either 1.5 or 2.25 lbs of MH per gal. The 1.5 lb per gal. formulation has traditionally been the product of choice in Virginia though either is acceptable if the correct application rate is used.

7. Don’t add spray surfactants to MH applications. Product labels for MH do not state either their usefulness or necessity. Research has not shown their effectiveness in increasing rainfastness.

Research is ongoing at the Southern Piedmont Center toward management practices to reduce MH residues. Early results are encouraging but additional testing is necessary before changes can be made to current

practices. One such test has been the comparison of MH applications made at 8 a.m., noon, and 4 p.m. Results from 2012-15 show consistently lower MH residues with the early morning application with no reduction in sucker control when applied in a sequential program with flumetralin.

MH Plant Factors Study

A multi-year study is underway at the Southern Piedmont Center to investigate various plant related factors that may impact MH residues in cured tobacco. One such factor is the time of day when MH is applied to a tobacco field. The physiological condition of plants changes throughout the day due to changes in moisture, temperature, and sunlight. These daily changes in plant stress levels impact how MH is absorbed into the plant to control suckers and how MH is metabolized within the plant and broken down.

The study compared MH applications made at 8 a.m., noon, and 4 p.m. Additionally, applications were made either before the first harvest, after the first harvests, or later after first harvest. The three applications were typically spaced 13 days apart over the past 4 years. A rate of 1.5 gal/ac (2.25 lbs a.i. per acre) was applied to all treatments in a sequential sucker control program with contact fatty alcohol and flumetralin.

Four-year averages of MH residues from tobacco in the fourth harvest are shown in Table 8. Additionally, the range in seasonal average MH residues that resulted from each treatment is shown below the 4-year average. Cured leaf MH residues were consistently lower with applications made before the first harvest with the overall average and the ranged in season averages below an 80 ppm tolerance. In contrast, applications made at noon and 4 p.m. after the first harvest were consistently above 80 ppm. Residues below 80 ppm occurred only in one year out of four.

Table 8. Cured leaf MH residues from the final harvest of tobacco treated with MH at three times of day. Applications were made on three dates relative to the first harvest. Data shown are averages of 4 years of tests from 2012-2015. Values in parentheses are the range of seasonal averages in MH residues.

Timing of MH application	Time of day for MH application		
	8 a.m.	Noon	4 p.m.
Before 1st harvest	**33** (19 - 53)	**53** (30 – 64)	**44** (22 – 78)
After 1st harvest	**49** (33 – 66)	**101** (70 – 154)	**105** (87 – 124)
Late after 1st harvest	**50** (31 – 70)	**101** (75 – 159)	**115** (68 – 159)

Test results show that an early morning application of MH is an effective means of reducing MH residues compared to applications made later in the day. No significant differences were observed in the level of sucker control obtained. Additionally, if MH residues in the tobacco of from the first harvest are not a concern, application before the harvest will effectively reduce MH in tobacco of later harvests. If MH is prohibited in the first harvest tobacco, then the rate of MH applied afterwards should be reduced (1 gal. rather than 1.5 gal./ac) to address MH residue concerns.

Suggestions for MH-Free Sucker Control

Dropline application of flumetralin has been long proven to be an effective alternative to the use of MH and specific details are described later as Program II. Worker safety and following label requirements with regard to PPE must be a consideration.

More recently, over-the-top spray applications of flumetralan have been successfully used in place of MH. Application of flumetralin should follow 2 or 3 applications of a fatty alcohol. Although labeled up to 1 gal. per ac, 2 to 3 qt/ac of flumetralin will be sufficient in most circumstances. If 3 qts are used, this should be spilt as two applications with 2 qts applied 1 week after the last contact and followed with 1 qt 3 to 4 weeks later.

Flumetralin does not provide the true systemic activity of MH and therefore the spray material must contact a small sucker in every leaf axil. This may not be feasible with crooked or windblown stalks. Likewise, spray nozzles

must be positioned properly over the plants for optimum control. This best achieved by spraying the same number of rows as the crop is transplanted.

Chemical Sucker Control Materials

Three types of chemicals are currently available for sucker control. Growers should have a basic understanding of how the various chemicals work in order to most effectively use them.

1. Contacts (fatty alcohols) quickly kill suckers by burning and must come in contact with the suckers to be effective. Suckers should begin to turn brown within an hour of contact application. A sufficiently concentrated solution of contact material is required to obtain adequate sucker control. Use a 4% solution or 2 gal. in 48 gals of water.

   The strength of a contact fatty alcohol product is dependent on carbon chain length of the fatty alcohols. Products traditionally used in Virginia are a mixture of C_6, C_8, C_{10} and C_{12} alcohols while products containing only C_{10} alcohols are available. To avoid possible injury, C_{10} products should be used at lower concentrations than mixed alcohol products (3 and 4% concentration of a C_{10} product would be comparable to 4 and 5% concentration of a mixed alcohol product, respectively).

2. Systemic sucker control chemicals or maleic hydrazide (MH) restrict sucker growth physiologically by stopping cell division. The only growth made after MH is applied is in the expansion of cells already present in the plant. To reduce MH residues on the cured tobacco, only one application of up to the labeled rate of MH must be applied per season. Wait at least one week between MH application and harvest.

3. Products that have a local systemic mode of action stop cell division in a localized area and must wet the sucker buds in each leaf axial to be effective. The primary local systemic material flumetralin and is sold under the trade names of Prime+, Flupro, and Drexalin Plus. Affected suckers will have a yellow, deformed appearance.

Precautions with contacts:

1. Control is achieved when suckers are small (not over one inch long).
2. Never spray foam from tank; this will increase the likelihood of burning leaves.
3. Do not spray extremely succulent tobacco (tobacco with a light green to creamy white bud area). This indicates a fast rate of growth.
4. Rain within an hour after application of contacts may reduce their effectiveness.
5. In order to kill both primary and secondary suckers, contact solutions should not be applied at concentrations less than 4%. It may be necessary to increase the concentration to 5% when applications are made under cool overcast weather conditions.

Precautions with local systemics:

1. Rain occurring within 2 hours after spraying may reduce effectiveness.
2. Applications to leaning plants, wet plants, or wilted plants may reduce effectiveness.
3. Applications made before the elongated button stage of growth may result in chemical topping or distortion of leaves that were too immature at time of application.
4. Sucker buds must be directly contacted to obtain control. Control is reduced if suckers are allowed to grow too large before application (greater than 1 in.).
5. Flumetralin residues may carryover in the soil to injure small grain and corn, and has been reported to stunt early season growth of tobacco when used with dinitroaniline herbicides such as Prowl. Fall disking and deep tillage are suggested to mitigate this potential.

Precautions with systemics:

1. Do not apply during the hot part of the day when leaf stomata are closed.
2. Rain within six hours after application of MH may reduce control. Research has shown that if a significant rain occurs more than three hours after application, only a half rate of MH should be reapplied to maintain good sucker control.

EPA WORKER PROTECTION STANDARDS

Read and follow all label directions regarding EPA Worker Protection Standards (WPS). Growers must follow requirements for personal protective equipment (PPE) and restricted entry intervals (REI).

Suggested Sucker Control Programs

Program I. Sequential Method

1. Apply contact sucker control chemical (4% concentration) before topping when approximately 50 to 60% of plants reach the button stage. A small percentage (5%) of plants should be chemically topped by this application.
2. A second contact application (5% concentration) should be made 3-5 days after the first. Fields having irregular growth will require a third application (5% concentration) 5-7 days later.
3. About 5 to 7 days after the last contact, apply one of the following alternatives:

    a) MH (only one application per season); or
    b) FST-7, Leven-38 or a contact and MH tank mix; or
    c) tank mix of MH with flumetralin
    d) flumetralin (up to 1 gal per acre but 2 to 3 qts is suggested)

4. Flumetralin may be substituted for the last contact application and delay an application of a reduced rate of MH until after the first harvest.
5. If control of late season sucker growth is necessary, one of the following alternatives may be applied 3-4 weeks after MH application:

    a) Flumetralin
    b) 5% concentration of contact material

Program II. Individual Plant Method with a Flumetralin

Apply flumetralin with a dropline, backpack, or jug when plants reach the elongated bud stage. Usually two or perhaps three trips are required to remove tops and treat all plants in a field. Individual plants should not be treated more than once. **Growers are reminded to comply with all label directions regarding worker protection standards (WPS).**

Whether applied with jugs or with droplines, hand application of sucker control chemicals is problematic in regard to worker exposure to pesticides and issues related to worker protection standards (WPS). Complying with personal protection equipment (PPE) requirements for WPS is challenging for hand application of sucker control chemicals.

Chemical Sucker Control Test

A sucker control test was conducted at the Southern Piedmont Center in 2016 to compare treatments of reduced rates of MH and MH-free treatments. The treatment applications described in Table 9 were applied following two contact fatty alcohol applications at 4 and 5%. All applications were made

with 3 nozzles per row (2 TG-3 and 1 TG-5). Pre-topping suckers were removed but any suckers that escaped control from the chemical applications were allowed to grow until the end of the season. The level of sucker control is expressed as the percent sucker control compared to a topped-not-suckered treatment where no chemical sucker control was applied.

Reasonable sucker control was obtained from all treatments with the possible exception of no. 7 where only 2 qts/a of Flupro was applied. Among the MH-free treatments, 90% or better control occurred with the addition of a contact fatty alcohol (Off-Shoot T) to the first Flupro application. Butralin is an alternative dinitroaniline product that can be used to reduce the amount of flumetralin applied. Although trt. no. 4 with Butralin provided the highest level of sucker control among the MH-free treatments, the differences in sucker control with the comparative treatment (no. 3) with the addition of a 3 qt of Flumetralin is likely of little practical importance. Similarly, the addition of a 5% rate of the fatty alcohol to the Flupro application was not significant, but tended to improve sucker control. Whether this is a direct result of the contact fatty alcohol activity or improved wetting of the suckers that may occur with the addition of fatty alcohol to the DNA product needs to be further studied.

The systemic activity of MH is important is controlling suckers not controlled by contact fatty alcohols locally systemic DNAs. Improved sucker control was generally observed with the addition of MH to the sequential sucker control treatments in this test. However, results of this test show that reduced rates of MH can be used to obtain good sucker control. Reducing the MH application rate is one of the most effective means of reducing MH residues in cured tobacco. One gal of MH applied either before first harvest (trt. no. 9) or after first harvest (trt. no. 10) provided sucker control equivalent to 1.5 gal of MH (trt. no. 8). Furthermore, a 0.5 lb rate of MH provided similarly good sucker control with the addition of a third qt. of Flupro (trt. no. 11) though control was reduced where only 2 qt of Flupro were applied (trt. no. 12).

Table 9. Reduced MH and MH-Free Sucker Control Test Conducted at the Southern Piedmont Center, Blackstone, Va. 2016.

Trt. No.	Application no. before 1st Harvest	Application no. after 1st Harvest	Sucker Control (%)[1]
1	Topped-Not-Suckered	(used to calculate sucker control)	
MH-Free Treatments[/2]			
2	OST + Flupro 5% + 3 qt/ac	----	92.4 bc
3	OST + Flupro 5% + 2 qt/ac	Flupro 1 qt/ac	91.9 bc
4	OST + Flupro 5% + 2 qt/ac	Butralin 1 qt/ac	95.6 ab
5	Flupro 2 qt/ac	Flupro 1 qt/ac	88.9 c
6	Flupro 3 qt/ac	----	87.1 dc
7	Flupro 2 qt/ac	----	82.8 d
Treatments with MH[/3]			
8	RMH-30 + Flupro 1.5 gal + 2 qt/ac	----	100.0 a
9	RMH-30 + Flupro 1.0 gal + 2 qt/ac	----	98.4 a
10	Flupro 2 qt/ac	RMH-30 1.0 gal/ac	100.0 a
11	RMH-30 + Flupro 0.5 gal + 2 qt/ac	Flupro 1 qt/ac	97.0 ab
12	RMH-30 0.5 qt/ac	Flupro 2 qt/ac	89.7 c

[/1]Percent sucker control values followed by the same letter are not significantly different.

[/2]Flupro is one of three flumetralin products labeled for tobacco, alternatives include Prime+ and Drexalin Plus. Use rates are the same for all three products.

[/3]Royal MH-30 was used for this test (1.5 lbs a.i. per gal.)

Suggestions for Application of Sucker Control Materials

Product Type	When to Apply	Application Rate
Contacts (fatty alcohols)	1. 1st appl. at 50% elongated button 2. 2nd appl. 3 to 5 days after 1st appl. 3. Late season application 3 to 4 weeks after MH, if needed	1st application as a 4% solution or 2 gal in 48 gal of water 2nd application as a 5% solution or 2.5 gal in 47.5 gal of water C_{10} products are applied at 3 and 4% for the 1st and 2nd applications, respectively
	Application Procedure Power Spray 20 psi using 3 solid cone nozzles per row (i.e. 1 TG-5 and 2 TG-3's) Apply 50 gal of spray material per acre Hand Application 20 psi max. and ½ to 2/3 fl oz per plant	
Local systemics (flumetralin)	1. Individual plants at elongated button stage (dropline or jug application) 2. 5 days after 1st contact application 3. Late season application 3 to 4 weeks after MH, if needed	Power Spray 2 qt/a of flumetralin Apply 50 gal of spray material per acre. Hand Application 2% solution or 1 gal in 49 gal of water (2.5 fl oz of flumetralin per gal of water). Do not apply more than 30 gal of spray per acre
	Application Procedure Power Spray 15 - 20 psi using 3 solid cone nozzles per row (i.e. 1 TG-5 and 2 TG-3's) Hand Application coarse spray (20 psi and TG-3 or 5 nozzle) or drench using jugs and apply ½ to 2/3 fl oz per plant depending on height	

Suggestions for Application of Sucker Control Materials (Cont'd)

Product Type	When to Apply	Application Rate
Premix product of fatty alcohol and flumetralin (Plucker Plus)	1. Apply from elongated button to full flower, either before or after topping (apply within 24 hours of topping) 2. A second application can be made 5 to 7 days after the first 3. May be applied following an MH application	Power Spray Up to 4 qt/a with 2 to 4 qt/a in sequence with MH Apply 50 gal of spray material per acre. Hand Application 1 gal in 49 gal of water (2.5 fl oz of per gal of water). Do not apply more than 30 gal of spray per acre
Application Procedure Power Spray 15 - 20 psi using 3 solid cone nozzles per row (i.e. 1 TG-5 and 2 TG-3's) Hand Application coarse spray (20 psi and TG-3 or 5 nozzle) or drench using jugs and apply ½ to $^{2}/_{3}$ fl oz per plant depending on height		
Systemics (MH)	When used as part of sequential control program - apply 1 week after 2nd contact application.	2.25 to 3.0 lb of MH (1.5 to 2 gal of 1.5 lb/gal product) (1 to 1.33 gal of 2.25 lb/gal product) Apply 40 to 50 gal of spray material per acre.
Application Procedure Apply as a coarse spray using 3 solid cone nozzles (i.e. TG-5 and 2 TG-3's). Direct spray toward upper third of the plant.		
Tank mix of MH with flumetralin	When used as part of sequential control program - apply 1 week after 2nd contact application.	2.25 to 3.0 lb MH with 2 qt/A of flumetralin Apply 50 gal of spray material per acre.
Application Procedure Apply as coarse spray using 3 solid cone nozzles (i.e. TG-5 and 2 TG-3's) and 20-25 psi.		

CHEMICAL COLORING AGENTS

Ethy-gen and ethephon are products reputed to aid in "coloring" tobacco and reduce the yellowing time during curing. Growers should not expect these products to solve problems such as ripening late maturing tobacco that is over-fertilized.

Ethy-gen is released in the barn during the yellowing stage of the cure. Ethephon is the only approved chemical to use for coloring tobacco in the field. The yellowing obtained from an ethephon application is influenced by weather conditions. Experience has shown that cool, cloudy conditions slow the yellowing rate and coloring may not be uniform. If a producer decides to use ethephon, a few representative test plants should be sprayed and observed for two to four days to determine if desired yellowing can be achieved. If the test plants fail to yellow as desired, further maturing may be needed before the crop should be sprayed. Only physiologically mature leaves remaining on the plant after the second or third priming should be treated. Ethrel (2 lbs per gal) was the original ethephon product labeled as a yellowing agent for tobacco and was followed by Prep, Boll Buster, and Marture XL (6 lbs per gal). Additional generic products have been labeled in recent years. **The use of other chemicals for this purpose is illegal and could result in severe penalty for the grower.**

Growers should follow manufacturer's suggestions on proper use of these materials.

Guidelines for the Use of Ethephon (6 lbs per gal. products)*

Application method	Rate pts/a	Spray volume	Application directions
Directed spray	$1^1/_3$	50 to 60 gal/A	Apply with drop nozzles to direct spray to leaves to be harvested. Use coarse spray tips at 35 to 40 psi.
Over-the-top	$1^1/_3$ to $2^2/_3$	40 to 60 gal/A	Apply as a fine spray using three spray tips over each row to cover all leaves thoroughly. Use a spray pressure of 40 to 60 psi.

*Read and follow all label directions regarding use rates, application procedures, and worker protection standards (WPS). Growers must comply with label requirements regarding worker notification, restricted-entry interval (REI), and personal protective equipment (PPE).

FLUE-CURED TOBACCO DISEASE CONTROL

Yuan Zeng, Extension Plant Pathologist, Tobacco

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 for black shank, Granville wilt, mosaic, as well as cyst and root-knot nematodes, are available to flue-cured tobacco growers in Virginia.

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.

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.

Table 1. Usefulness of various rotation crops for tobacco disease control[1].

			Nematodes			
Rotation Crop	**Black Shank**	**Granville Wilt**	**Root-Knot**	**Tobacco Cyst**	**Tobacco Mosaic Virus**	**Black Root Rot**
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[3]	H	H	L
Corn	H	M	L	H	H	H
Sweet potato	H	M	L[4]	-	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[2]	L	N	H
Potato, Irish	H	N	L	L	H	H
Tomato	H	N	N[3]	N	N	M

[1]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.

[2]May be highly valuable for some species or races of root-knot nematodes

[3]However, root-knot resistant cultivars can be highly effective rotation crops for tobacco.

[4]Root-knot resistant sweet potato cultivars are moderately effective rotation crops for tobacco.

Table 2. Steps in early stalk and root destruction.

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.

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 steamed or treated. Mosaic has a number of weed hosts (horsenettle, ground cherry) which should all 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 (*Rhizoctonia* and *Pythium*). As methyl bromide is no longer available, trays can be treated with aerated steam, maintained at 160^0F to 175^0F for at least 30 minutes, to minimize damping-off and sore shin diseases.

Never use water from streams or ponds in a tobacco greenhouse, 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 for collar rot, as well as angular leaf spot and wildfire (two other bacterial diseases) 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.*

Table 3. DISEASES OF TOBACCO SEEDLINGS

Disease	Material	Rate
Pythium Root Rot (*Pythium* spp.)	Terramaster 4EC	Preventative: 1.4 fl oz/100 gal may be applied twice, as long as applications are 3 weeks apart. 1.0 fl oz/100 gal may be used as a third application as long as it is made no later than eight weeks after seeding. Curative: 1.4 fl oz/100 gal 2nd Curative: 1-1.4 fl oz/100 gal.
Remarks: 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 3.8 fl.oz./100 gallons of water may be applied to any crop of transplants, regardless of the number of applications. **MUST BE EVENLY DISTRIBUTED**. When mixing, *first form dilute emulsion*, then distribute diluted emulsion evenly and thoroughly in float bed water.		
Target Spot *(Thanatephorus cucumeris);* **Blue Mold** *(Peronospora tabacina)*; **Anthracnose** *(Colletotrichum gloeosporioides)*	Penncozeb 75DF	0.5 lb/100 gal (1 level tsp/gal)
Remarks: 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. *Some tobacco companies may prohibit use of mancozeb products like Penncozeb in 2020.*		
Target Spot (*Thanatephorus cucumeris*)	Quadris	0.14 fl oz (4 ml)/1,000 sq.ft. (6.0 fl oz/A)
Remarks: 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.		
Blue mold *(Peronospora tabacina)*	Aliette	0.5 lb (8 oz)/50 gal
Remarks: Foliar spray; apply no more than 0.6 lb/1,000 sq.ft; **CAN BURN PLANTS IF WASHED INTO MEDIA OR FLOAT WATER**; no more than 2 sprays/greenhouse season.		
Angular Leaf Spot or Wildfire (*Pseudomonas syringae*)	Agri-mycin 17, Fire-wall 17WP, Harbour, etc.	100-200 ppm (2-4 tsp/3gal)
Remarks: 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.		

Black shank is caused by a fungus-like pathogen that lives in soil and attacks tobacco roots and stalks. Tables 4, 5 and 9 present black shank resistance ratings for flue-cured tobacco varieties. *Virginia tobacco producers should assume that most of their fields contain race 1 of the black shank pathogen. In addition to planting a variety with high resistance to race 1, growers planting black shank problem fields in 2021 should apply a black shank fungicide at first cultivation and/or at layby in addition to use in the transplant water* (Table 10). Remember that while soil fumigants provide good to excellent control of Granville wilt and nematodes, they are generally not effective for black shank control.

Table 4. Reactions to Race 1 Black Shank by Flue-Cured Tobacco Varieties possessing the *Ph$_p$* gene.

		Relative Yield Index[3]	
Varieties with the *Ph* gene[1]	Percent Survival[2]	With Black Shank	Without Black Shank
NC 1226[4]	99	106	108
NC 196	73	74	102
PVH 1452	66	67	101
CC 700	67	66	98
PVH 1600	64	64	100
NC 72	57	57	100
CC 67	69	55	92
NC 299	47	47	100
CC 27	39	41	105
NC 297	37	38	103
CC 37	39	37	94
PVH 2310	30	30	100

[1] Varieties with the *Ph$_p$* gene possess very high resistance to race 0 of the black shank pathogen. Resistance to race 0 in varieties without the *Ph$_p$* gene is similar to or higher than that to race 1.

[2] Average % Survival without a soil fungicide from 3 years of field testing by North Carolina State University. Source: 2020 Tobacco Production Guide, Managing Diseases, Table 8.3.

[3] 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 2015-2020 Virginia OVT tests conducted at the Southern Piedmont AREC, Blackstone. Yield indexes for "Black Shank (race 1)" = yield index without black shank multiplied by 2019-2020 NCSU Black Shank-% Survival ratings.

[4] Tentative ratings based on the limited data available in December 2020.

Table 5. Reactions to Race 1 Black Shank by Flue-Cured Tobacco Varieties that don't possess the *Ph_p* gene.

Varieties without the *Ph_p* gene[1]	Percent Survival[2]	Relative Yield Index[3] With Black Shank	Relative Yield Index[3] Without Black Shank
GL 386[4]	94	96	102
CC 35	82	95	116
NC 925	92	92	99
CC 1063	92	89	97
NC 938	87	87	100
CC 145[4]	91	82	90
K 346	85	80	93
NC 606	77	74	96
CC 33	71	68	95
GL 395	67	63	94
CC 143	56	58	105
GL 26H	53	57	108
CC 13	57	57	100
PVH 2254	50	50	101
PVH 2110	50	53	107
K 326	37	39	105

[1] Varieties with the *Ph_p* gene possess very high resistance to race 0 of the black shank pathogen. Resistance to race 0 in varieties without the *Ph_p* gene is similar to or higher than that to race 1.
[2] Average % Survival without a soil fungicide from 3 years of field testing by North Carolina State University. Source: 2020 Tobacco Production Guide, Managing Diseases, Table 8.3.
[3] 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 2015-2020 Virginia OVT tests conducted at the Southern Piedmont AREC, Blackstone. Yield indexes for "Black Shank (race 1)" = yield index without black shank multiplied by 2019-2020 NCSU Black Shank-% Survival ratings.
[4] Tentative ratings based on the limited data available in December 2020.

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 6, 7, 9, and 10). *Wilt-resistant varieties reduce infection through roots, but not stalks (infections that occur via mechanical toppers and/or tobacco harvesters)*. See Table 6. Topping and harvesting equipment should be adjusted and sanitized carefully before and after use in fields infested with the Granville wilt pathogen.

Table 6. Performance of selected flue-cured tobacco varieties in 2020 on-farm test for resistance to Granville Wilt, Dolphin, VA.

	Final % Healthy Plants						
Variety	8 Jun	2 Jul	16 Jul	30 Jul	14 Aug	26 Aug	1 Sep
PVH 1452	100	98	98	99	95	88	37
CC 145	100	97	95	96	94	80	50
PVH 1920	100	97	95	96	88	74	29
NC 196	100	96	95	93	90	65	29
CC 143	98	95	94	91	90	62	30
CC 27	99	97	94	94	94	59	27
NC 1226	100	97	94	94	93	55	17
CC 35	98	94	91	91	77	26	3

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. Production practices such as early root and stalk destruction, crop rotation, and resistant varieties reduce nematode populations over much longer periods of time than nematicides, and should therefore always be used in addition to nematicides.

Frequent use of varieties with the Ph_p 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 (Tables 4, 7 and 9). *Planting a variety without the Ph_p 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 2021 crop.

Table 7. Reactions of flue-cured tobacco varieties to Granville Wilt.

		Relative Yield Index[3]	
Varieties with the Php gene[1]:	% Survival[2]	With Disease	Without Disease
PVH 1452	53	67	101
CC 37	67	63	94
NC 297	55	57	103
CC 27	49	51	105
CC 67	53	49	92
NC 299	46	46	100
NC 196	40	41	102
CC 700	36	35	98
NC 1226[4]	12	13	108
Varieties without the Php gene[1]			
GL 386[4]	78	80	102
NC 606	67	65	96
CC 1063	53	52	97
NC 938	51	51	100
CC 143	46	48	105
K 346	85	46	93
GL 26H	42	45	108
GL 395	45	42	94
GF 318	41	42	101
CC 13	42	42	100
NC 925	42	42	99
CC 33	41	39	95
CC 145[4]	35	32	90
K 326	24	25	105
CC 35	12	14	116

[1] 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.

[2] Average % Survival without a soil fungicide from 3 years of field testing by North Carolina State University. Source: 2020 Tobacco Production Guide, Managing Diseases, Table 8.3.

[3] Relative 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 2015-2020 Virginia OVT tests at the Southern Piedmont AREC, Blackstone. Yield indexes for "with Granville Wilt" = yield index without Granville wilt multiplied by average % Survival.

[4] *Ratings based on limited data available.*

Except for the new cultivar CC 145, all flue-cured tobacco cultivars currently being grown are resistant to races 1 and 3 of the southern root-knot nematode (*Meloidogyne incognita*). However, 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*) are also now common in Virginia. The Guava root-knot nematode (*M. enterolobii*) is also currently spreading in a number of nearby states, including North Carolina. *Any galling on a "root-knot resistant" flue-cured tobacco cultivar indicates the presence of at least one of these other types of root-knot.* Flue-cured tobacco cultivars CC 13, CC 33, CC 35, and CC 37 are resistant to *M. arenaria* and *M. javanica* in addition to races 1 and 3 of *M. incognita*, and should significantly improve control of these species of root-knot nematodes (Table 9). However, no currently-grown tobacco cultivars possess resistance to *M. enterolobii*. Rotating tobacco with "non-host" crops will also reduce root-knot nematode populations (see Table 1), but forage legumes, such as clover, are often good hosts for root-knot. Sweet potato is a good host for *M. enterolobii*, so rotating flue-cured tobacco with sweet potato significantly increases the risk of that new nematode gaining a foothold or increasing in Virginia. Rotation intervals should be increased for as long as possible. Virginia growers should also be particularly careful when purchasing farm equipment and sweet potato planting stock from the Carolinas to avoid introducing this new and very damaging nematode into Virginia. Using an effective soil nematicide is advisable when crop rotation and resistant varieties aren't practical and preplant root-knot populations are high (Table 13). At this time, a maximum rate of Telone II is the only recommended nematicide treatment for fields where *M. enterolobii* has been detected.

Table 8. Interpreting Root-Knot Nematode infestation levels

Risk of Crop Loss	% Roots Galled	Nematodes/500 cc of soil: Fall Sample	Nematodes/500 cc of soil: Spring Sample	Control Options
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 to lesion nematodes 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.

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.

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, GL 26H, 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.

Target Spot, Frogeye, and Blue Mold can be significant problems for tobacco producers in Virginia. Quadris is registered for target spot control in both the greenhouse and field (Tables 3 and 10), but only one spray is allowed in the greenhouse. If applied shortly after the 1st clipping, this spray should provide good disease control for at least 3 to 4 weeks. Target spot can also reach damaging levels in the field as topping time nears. Timely harvest of lower leaves often reduces leaf diseases by increasing air flow in fields, allowing upper leaves to dry-out, but in wet weather leaf diseases can continue to get worse through the harvest period. Fungicide sprays can help minimize leaf spots through these conditions, but continued sequential use of

Table 9. Tobacco disease resistance in selected flue-cured tobacco varieties available in 2021.

	Resistance Rating						
				Nematodes			
	Black Shank[1]			Root-Knot			
Variety	*Ph*$_p$ gene (race 0 only)[2]	Race 1	Granville Wilt[1]	*M. incognita*	Other species[3]	Tobacco Cyst	Tobacco Mosaic Virus
CC 13	-	57	42	+	+	-	-
CC 27	+	39	49	+	-	+	+
CC 33	-	71	41	+	+	-	-
CC 35	-	82	12	+	+	-	-
CC 37	+	39	67	+	+	+	+
CC 67	+	60	53	+	-	+	+
CC 143	-	56	46	+	-	-	-
CC 145[4]	-	91	35	-	-	-	-
CC 700	+	67	36	+	-	+	-
CC 1063	-	92	53	+	-	-	-
GF 318	+	60	41	+	-	+	-
GL 26H	-	53	42	+	-	-	+
GL 386[4]		94	78	+	-	-	-
GL 395	-	67	45	+	-	-	-
K 326	-	37	24	+	-	-	-
K 346	-	85	49	+	-	-	-
NC 196	+	73	40	+	-	+	-
NC 297	+	37	55	+	-	+	+
NC 299	+	47	46	+	-	+	-
NC 606	-	77	67	+	-	-	-
NC 925	-	92	42	+	-	-	-
NC 938	-	87	51	+	-	-	-
NC 1226[4]	+	99	12	+	-	+	-
PVH 1452	+	66	53	+	-	+	-
PVH 2310	+	30	37	+	-	+	-

[1] Resistance rating = "% Survival", the average % plants still alive near 2nd or 3rd harvest, without a soil fungicide or fumigant. See Tables 4-7 for more detailed information.
[2] Varieties with the *Ph*$_p$ gene are almost immune to race 0 of the black shank pathogen; resistance to race 0 without the *Ph*$_p$ gene is at least as high as resistance to race 1.
[3] "Other species" include *Meloidogyne arenaria* or *M. javanica*, which are now common in Virginia. All flue-cured tobacco varieties are thought to be susceptible to the guava root-knot nematode (*M. enterolobii)*, but this nematode has not been detected in Virginia.

[4] *Ratings based on limited data available.*

similar fungicide chemistries (FRAC groups) can lead to fungicide insensitivity within the target pathogens. Unfortunately, ***insensitivity to azoxystrobin (the active ingredient in Quadris) has been detected in tobacco leaf spot pathogens in both Kentucky and North Carolina every year since 2017. Similar fungicide insensitivity in Virginia populations of these pathogens is likely.*** Tobacco producers have no similarly effective fungicide alternative to Quadris for target spot and frogeye leaf spot control. Because these pathogens may develop increased insensitivity if Quadris is applied "back-to-back**", *growers are strongly encouraged to alternate application of Quadris with other foliar fungicides registered for use on tobacco*** in order to slow the spread of Quadris-resistant populations of the target spot and frogeye pathogens. Multiple fungicides are available for blue mold control and are listed in Tables 3, 11 and 12 of this chapter.

APPLICATION METHODS

Pesticide performance and safety is dependent on use of proper application methods. Proper pesticide use depends upon correct diagnosis of the problem, a clear understanding of the pesticide label, proper calibration of application equipment, and strict adherence to label directions and all federal, state and local pesticide laws and regulations.

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 in 20-100 gallons per acre at 40-100 psi to maximize coverage as plants increase in size. Use of drop nozzles should 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 soil fumigants containing chloropicrin or metam sodium. Tobacco producers who plan to fumigate soil need to familiarize themselves with all requirements involved with use of the specific 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 10. FIELD DISEASES OF TOBACCO: ROOT AND STEM DISEASES

			Disease[2]	
Product	Rate/A	Application Method[1]	Black Shank	Granville wilt
Orondis Gold 200[3] + Ridomil Gold SL	4.8 fl oz + 6-8 fl oz	TPW	E	---
Orondis Gold Premix[3]	24-28 fl oz	TPW	E	---
Presidio[4]	4.0 fl oz	1st cultivation or layby	VG	---
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[5] + 1st cultivation and/or layby	VG	---
Ridomil Gold SL	1 pt + 1 pt	1st cultivation + layby	VG	---
Ultra Flourish	2 pt + 2 pt	1st cultivation + layby	VG	---
MetaStar 2E AG	4 pt + 4 pt	1st cultivation + layby	VG	---
Ridomil Gold SL	1 pt + 1 pt + 1 pt	PPI + 1st cultivation + layby	VG	---
Ultra Flourish	2 pt + 2 pt + 2 pt	PPI + 1st cultivation + layby	VG	---
MetaStar 2E AG	4 pt + 4 pt + 4 pt	PPI + 1st cultivation + layby	VG	---
Ridomil Gold SL	1-3 pt	PPI	F	---
Ultra Flourish	2-6 pt	PPI	F	---
MetaStar 2E AG	4-12 pt	PPI	F	---
Telone C-17	10.5 gal	F-Row	P-F[5]	G
Chlor-O-Pic	3 gal	F-Row	P-F[5]	G
Chloropicrin 100	3 gal	F-Row	P-F[5]	G
Pic Plus	4 gal	F-Row	P-F[5]	G

[1]PPI – broadcast, preplant-incorporated spray; TPW – addition of fungicide to water applied to furrow during transplanting; 1st cultivation – broadcast spray just *before* 1st 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; 9.6 fl oz Orondis Gold 200 or 27.8 fl oz Orondis Gold Premix; or 8 fl oz Presidio per acre per season.

[2]Control rating – F=fair; G=good; VG=very good; E = Excellent. (-) – No disease control or not labeled for this disease.

[3]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 using a non-FRAC 49 product. 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 helps reduce risk of plant injury. Use higher rate for heavier soils or more susceptible varieties. Do not follow soil use with foliar sprays of any FRAC 49-containing product.

[4]Apply Presidio as a field spray after use of a different fungicide at or near transplanting. Presidio may be applied at 1st cultivation or layby, but not both.

[5]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 using a non-FRAC 4 product. . Use higher rates for heavier soils or more susceptible varieties.

[5]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 11. FIELD DISEASES OF TOBACCO: TARGET SPOT, FROGEYE, etc

Disease	Material	Rate	Application Method[1]
Target Spot (*Thanatephorus cucumeris*); **Frogeye** (*Cercospora nicotianae*); **Blue mold** (*Peronospora tabacina*).	Quadris	6-12 fl. oz.	Foliar Spray
Remarks: 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. Spray in sufficient water volume for complete coverage and canopy penetration. Research indicates 8-9 fl. oz/ Quadris/A usually provides optimal target spot control. Don't spray Quadris "back-to-back" but alternate with another fungicide from a different FRAC group. *Quadris now has a 21-day pre-harvest interval (PHI).* These restrictions will limit the maximum number of Quadris sprays to 2-3/field growing season. May enhance weather flecking; tank-mixing with EC pesticides or those containing high amounts of solvents may increase that effect.			
Target Spot (*Thanatephorus cucumeris*); **Blue mold** *Peronospora tabacina*); **Anthracnose** (*Colletotrichum gloeosporioides*)	Penncozeb 75 DF	1.5-2.0 lb/100 gal water	Foliar Spray
Remarks: Begin sprays when conditions favor disease and continue on a 5-7 day interval until the threat of disease subsides. Penncozeb shouldn't be applied within 6 weeks of first harvest to avoid excessive leaf residues. *Some tobacco companies may not purchase leaf treated with mancozeb fungicides like Penncozeb*.			

[1]Apply at 40-100 psi in 20 gal of water up to layby and up to 100 gal of water near topping. Higher spray volumes are important in maximizing coverage, which is important in achieving desired disease control. Use hollow-cone nozzles (TX12, etc.) Use of drop nozzles after layby stage should increase coverage on lower leaves where disease starts and is often concentrated.

Table 12. FIELD DISEASES OF TOBACCO: BLUE MOLD

Disease	Material	Rate	Application Method[2]
Blue mold *(Peronospora tabacina)*	Revus	8.0 fl.oz/A[1]	
Remarks: 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 with a different mode of action. Use sufficient spray volume to provide thorough coverage. Adding a spreading/penetrating surfactant (non-ionic) may improve results.			
Blue mold *Peronospora tabacina*)	Forum + Penncozeb 75 DF	7.0 fl oz + 2.0 lb/100 gal water[1]	Foliar Spray
Remarks: Begin sprays when conditions favor disease and continue on a 5-7 day interval until the threat of disease subsides. Do not exceed 8 fl.oz./A of Forum per application or 30 fl.oz./A per season. Penncozeb shouldn't be applied within 6 weeks of first harvest to avoid excessive leaf residues. *Some tobacco companies may not purchase leaf treated with mancozeb fungicides like Penncozeb.*			
Blue mold *Peronospora tabacina*)	Orondis Ultra A + Orondis Ultra B	2.0 - 4.8 fl oz + 2.0 - 4.8 fl oz/100 gal water[1]	Foliar Spray
Remarks: Begin sprays when conditions favor disease and continue on a 7-10 day interval until the threat of disease subsides. Do not exceed 19.2 fl.oz./A per season. Do not follow soil use of Orondis with foliar sprays. Make no more than 2 sequential applications before rotating to a different fungicide to avoid fungicide resistance.			
Blue mold *Peronospora tabacina*)	Ridomil Gold EC Ultra Flourish MetaStar 2E AG	0.5-1 pt + 0.5 pt/A[1] 1-2 pt + 1 pt/A[1] 2-4 pt + 2pt[1]	Preplant + Layby
Remarks: Strains of the blue mold pathogen are often insensitive to mefenoxam, but mefenoxam may control sensitive strains early in the season, as well as *Pythium* damping-off. Read precautionary and rotation crop restrictions.			
Blue mold *Peronospora tabacina*)	Aliette	2.5-4.0 lb/A[1]	Foliar
Remarks: No more than 5 sprays allowed, 3 day pre-harvest interval; don't tank-mix.			
Blue mold *Peronospora tabacina*);**Tomato Spotted Wilt Virus** (TSWV)	Actigard 50WP	0.5 oz/20 gal/A	Foliar
Remarks: Begin applications when blue mold disease threatens and plants are at least 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.			

[1]Use higher rates when disease is already present, for longer application intervals, or for more susceptible varieties. Mix 20-30 gal/A of spray solution for sprays during the first several weeks after transplanting; gradually increase spray volume to 40 gal/A by layby and 80-100 gal/A on tobacco ready to be topped.

[2]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 13. TOBACCO NEMATICIDES

		Nematodes[1]			
		Root Knot			
Product	Rate/A, Application Method[3]	Meloidogyne incognita, arenaria, javanica	M. enterolobii[2]	Tobacco Cyst	Lesion Nematodes
Fumigants					
Chlor-O-Pic	3-4 gal	E	P-F	G	E
42% Metam products	25 gal	?	?	G	?
Pic Plus	4.2 gal	E	P-F	G	E
Telone II	6 gal	E	P-F	F	E
Telone II	9-10 gal	E	G	VG	E
Non-Fumigants					
Nimitz[4]	3.5-7.0 pt/, PPI	F-G	P-F	F-G	F
Velum Prime	6.5-6.87 fl oz, TPW	F-G	P-F	F-G	F

[1] Control ratings: E=Excellent; VG=Very Good; 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.

[2] Tentative ratings based on North Carolina State University ratings for *M. enterolobii* control.

[3] Soil fumigant rates assume injection 8 inches deep through a single shank in each row - 21-day waiting period before planting. 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; TPW= transplant water application.

[4]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).

[5]Do not apply more than 13.7 fl oz of Velum Prime (0.446 lbs fluopyram) per acre per year, regardless of formulation or method of application. Pre-harvest interval = 30 days. To limit potential development of pest resistance to fluopyram, the first foliar fungicide spray after use of Velum Prime should involve a product from a FRAC Group other than FRAC 7.

DISEASES OF TOBACCO

There Are No Chemical Controls For the Following Diseases

Disease	Remarks
Botrytis Blight (*Botrytis cinerea*)	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 (*Alternaria alternata*)	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 (*Sclerotinia sclerotiorum*)	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, *Bacillus cereus*, 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.

WEED CONTROL IN FLUE-CURED TOBACCO

Yuan Zeng, Extension Plant Pathologist, Tobacco

Good weed control uses crop rotation, early root and stalk destruction, cultivation, and appropriate use of herbicides. Application of an herbicide before transplanting (PRE, PPI) or over-the-top at transplanting (OT) will reduce reliance on tillage and cultivation for early season weed control. Some herbicides may also be applied to the row middle just after the last cultivation to extend weed control later in the growing season. Herbicide use should be based upon the specific weeds present in each field, the weed control program that integrates best with overall farm management practices, herbicide cost in relation to performance and crop safety, and anticipated rotational crops. Herbicide performance and safety are dependent upon the use of correct application methods. Special effort should be made to apply all herbicides exactly as stated on the product label.

IMPORTANT CONSIDERATIONS IN HERBICIDE USE

Selecting the Proper Herbicide

Weed Identification - Identifying the problem weeds in each field should be the first step in any weed control program. A good resource to help you accurately identify weeds can be found at

http://weedid.cals.vt.edu

Check herbicide labels to ensure that the products are active against the desired weeds. Using herbicides in rotation crops may reduce populations of hard-to-control weeds in tobacco fields. The table on page 68 is a relative summary of herbicide performance for the majority of weeds found in flue-cured tobacco fields in Virginia.

Soil Texture and Organic Matter Content - Herbicide rates should increase as percent organic matter increases and as soil texture changes from coarse to fine. However, the lowest recommended rate should always be used when percent organic matter is less than 1%, regardless of soil texture. The soil textures listed in herbicide labels and recommendations are as follows: Coarse Soils - sands, loamy sands, and sandy loams; Medium Soils - sandy clay loams, loams, silt loams, and silts; Fine Soils - clay loams, silty clay loams, and clays. The percent organic matter of your soils can be determined by taking a soil sample and submitting it to a soils laboratory for analysis.

Proper Herbicide Application

Soil Preparation – All weed growth and crop stubble should be thoroughly worked into the soil prior to application of most tobacco herbicides. Soil should be moist and loose, with all clods broken up, before a herbicide is applied.

Spray Equipment - A standard low-pressure (25 to 50 psi) boom sprayer should be used to apply herbicides. Although most herbicides should be applied in 20 to 40 gallons of water per acre, Poast should be sprayed in only 5 to 20 gallons of water per acre. Check for clogged nozzles and screens frequently while spraying. Use 50-mesh screens in strainers, nozzles, and suction units. Clean or replace dirty or worn-out sprayer, boom, and nozzle parts to ensure uniform application. Be sure to calibrate the sprayer before use to avoid crop injury and/or poor herbicide performance from improper spray volume or a non-uniform spray pattern. Ensure that the spray solution is continuously agitated. Do not apply a herbicide in strong wind, since wind can cause uneven coverage and potential spray drift damage to surrounding areas. Never leave a spray mixture in a sprayer overnight!

Herbicide Incorporation - Herbicides that require incorporation should generally be incorporated as soon after application as possible. Use a field cultivator or a combination, double disc, or disc harrow set to cut 4 to 6 inches deep, or a rotary tiller set to cut 2 inches deep. Avoid using a large field disc to incorporate PPI herbicides. Discs should be no more than 24 inches in diameter and no more than 8 inches apart. Shallow incorporation with implements set to cut less than 2 inches deep can result in erratic weed control. **A single cultivation does not adequately incorporate herbicides, and may increase crop injury and decrease weed control.** Incorporating equipment should be operated in two different directions, at right angles to each other, at 4 to 6 mph. P.T.O.-driven equipment (tillers, cultivators, hoes) perform best on coarse soil types. P.T.O.-driven equipment should be set to cut 3 to 4 inches deep and should not be operated at a speed greater than 4 mph. Tillage is often required with herbicide use over-the-top (OT) after transplanting. Irrigation is also often required to incorporate tobacco herbicides applied at layby. Using incorporation equipment and/or tractor speeds not listed on the product label may result in poor or erratic weed control and/or crop injury.

Undesired Effects of Herbicide Use

Effect of Preplant Applications on Early Season Tobacco Growth - Herbicides applied before transplanting sometimes inhibit root development of transplants, delaying plant growth during the first month after transplanting. Full season weed control can be obtained, and possible early season growth reductions avoided, by applying herbicides at transplanting and layby.

Effects of Herbicides on Rotation Crops - Residues from some tobacco herbicides may reduce growth of crops following tobacco. These effects are discussed in the labels for the particular herbicides involved. Potential carry-over can be reduced by: 1) using the minimum labeled rates for the chemical, for your weed problems, on your soils; 2) applying herbicides in a band at transplanting and/or layby rather than broadcast PPI; 3) fall tillage

for early root and stalk destruction; and, 4) by deep plowing after the final harvest and before seeding the cover or rotation crop.

FLUE-CURED TOBACCO HERBICIDES

No-Till Preplant Herbicides Apply in an even broadcast application, avoiding spray overlap. Use even, fan-type, flood-jet, or raindrop nozzles. Spartan Charge contains the same active ingredient as Spartan 4F (sulfentrazone), but Spartan Charge also contains carfentrazone (the active ingredient in Aim), as well as sulfentrazone. Both Spartan products may be surface-applied or incorporated (less than 2 inches deep) before transplanting, but not afterwards. *Tobacco leaves will burn if contacted by sprays containing Spartan Charge*. **PRE and PPI Preplant Herbicides** Apply evenly in a broadcast spray, avoiding overlap. Spartan 4F and Command 3ME are designed for surface application before transplanting and do not require mechanical incorporation. Apply these herbicides to the soil surface at least 12 hours before transplanting. Prowl and Devrinol require incorporation (PPI). Preplant tobacco herbicides should not be incorporated more than 2 inches deep.

Over-the-Top After Transplanting (OT) and Layby Herbicides
An OT application of Command 3ME can be made as either a band or broadcast application within 7 days of transplanting. An OT application of Devrinol 50DF or DF-XT may also be made immediately after transplanting. Devrinol should be shallowly incorporated, or irrigated in, if rainfall doesn't occur within 5 days of application.

1. Band Application - Apply the herbicide in a 14 to 24 inch band over the row using fan-type, even-spray nozzles (8004E, etc.). The amount of herbicide per acre of crop is reduced with band application and can be determined by the following formula:

$$\text{Lbs of Product/Acre} = \frac{\text{Band Width (inches)}}{\text{Row Spacing (inches)}} \times \text{Broadcast Rate per/A}$$

2. Broadcast Application - Apply the herbicide in an even broadcast application using a sprayer equipped with fan-type nozzles (8004, etc.).

Apply layby herbicides as directed sprays to row middles immediately after the last normal cultivation. Use drops equipped with flat, flood-jet (TK2, TK4, etc.) or even, flat-fan (8004, etc.) nozzles to apply the herbicide solution in a 16 to 30 inch band in the row middles. Use nozzles which apply one-half (½) the normal number of gallons per acre where spray nozzles on the end of the boom pass over the same row middle twice (to prevent over-application). Use the formula above to determine the amount of product to use for a band application. Irrigation will be required if 0.5 to 1 inch of rain does not fall within 7 to 10 days after application (to ensure herbicide activation).

RELATIVE EFFECTIVENESS OF HERBICIDES FOR TOBACCO*

Grasses and Nutsedge

Herbicide	Barnyard-grass	Bermuda-grass	Broadleaf Signalgrass	Crab-grass	Crowfoot grass	Fall Panicum	Fox-tails	Goose-grass	Johnsongrass (seedling)	Texas Panicum	Nut-sedge
Aim	N	N	N	N	N	N	N	N	N	N	N
Command & generics	E	P-F	E	E	E	E	E	E	G	G	P
Devrinol	G	P	G	E	E	G	E	E	F	-	N
Poast	G	G	E	G	F	E	E	G	E	E	N
Prowl & generics	G	P	G	E	E	G	E	E	G	G	N
Spartan & generics	F	P	F	F	F	F	F	F	P	F	E

Broadleaf Weeds

Herbicide	Carpet-weed	Cockle-bur	Galinsoga	Jimson-weed	Lambs-quarters	Morning-glory	Pig-weed	Purs-lane	Prickly sida	Rag-weed	Sickle-pod	Smart-weed
Aim	-	G	P	G	G	E	E	G	P	N	P	G
Command & generics	P	F	F	G	G	P	P	G	E	F	P	G
Devrinol	G	P	P-F	P	G	P	G	E	P	F	P	P
Poast	N	N	N	N	N	N	N	N	N	N	N	N
Prowl & generics	G	P	P	P	G	P	G	G	P	P	P	P
Spartan & generics	G	F-G	F	G	G	G	G	G	G	P	P	G

*E = 90 to 100% control; G = 76 to 90%; F = 50 to 75%; P = 20 to 50%; N = Less than 20%; - = no data. This table gives general ratings of relative herbicidal activity. Activity varies with weather conditions, soil type and application method. Under non-optimal conditions, activity may be less than indicated.

WEED CONTROL IN FLUE-CURED TOBACCO FIELDS

Weed Problems	Soil Texture	Chemical Lbs Active Ingredient/A	Product per Acre	Applic. Method
Pigweed, lambsquarters, nightshade, purslane, smartweed, velvetleaf, spurred anoda, carpetweed, cocklebur, cotton, groundcherry, morningglory, common ragweed		Carfentrazone 0.012-0.024 0.013-0.023	Aim 0.5-1.0 oz Aim EC or Aim EW 0.8-1.5 fl oz	Pretransplant burndown; shielded or hooded spray before layby; directed spray after 1st harvest. HRAC Group E.
Remarks: ***Spray solution will cause extensive burn to broadleaf plants (and tobacco leaves) on contact.*** Pre-transplant interval = 1 day; pre-harvest interval = 6 days. Do not apply more than 2.0 oz. Aim or 3.0 fl oz. Aim EC or EW per acre per season..				
Barnyardgrass, broadleaf signalgrass, crabgrass, field sandbur (suppression), foxtails, seedling Johnsongrass, fall panicum, velvetleaf, jimsonweed, lambsquarter, prickly sida, purslane, spurred anoda, venice mallow, common ragweed, smartweed, cocklebur (suppression), shattercane	 Coarse Fine	Clomazone 0.75 1.0	Command 3ME & generics 2.0 pt 2.7 pt	OT. HRAC Group F4.
Remarks: Consult specific product labels for details such as application rates. Use the higher rate for heavy weed pressure or heavy soils. Transplant roots should be placed below the treated area. Stands of grass cover crops may be reduced if planted within 9 months of application. Do not graze or feed cover crops planted less than 9 months after application.				
Barnyardgrass, carpetweed, crabgrass, fall panicum, foxtails, goosegrass, johnsongrass from seed, lambsquarters, pigweed, common purslane, ragweed (suppression), ryegrass; check label for uncommon weeds.	 Coarse Medium Fine	napropamide 1.0 1.0-1.5 2.0	Devrinol 50DF or DF-XT 2.0 lb 2.0-3.0 lb 4.0 lb	PPI, OT, Layby. HRAC Group K3.
	 Coarse Medium Fine	 1.0 1.0-1.5 2.0	Devrinol 2E, 2-XT 2 qt 2-3 qt 4 qt	PPI only. HRAC Group K3.
Remarks: For PPI application, incorporate the same day as applied. Small grain injury may result from PPI application method. Newer XT formulations include a UV light protectant.				

WEED CONTROL IN FLUE-CURED TOBACCO FIELDS (continued)

Weed Problems	Soil Texture	Chemical Lbs Active Ingredient/A	Product per Acre	Applic. Method
Grass weeds and volunteer small grain	All types	sethoxydim	Poast	Postemergence HRAC Group A.
	Single use:	0.28	1.5 pt + 2 pt oil concentrate	
	Sequential use:	0.19	1 pt + 2 pt oil concentrate	
Remarks: Apply to actively growing grasses in 5-20 gal/A. *Consult spray-additive (crop oil concentrate) label for appropriate rate to avoid crop injury*. May be banded or applied broadcast. Do not apply more than 4 pt/A per season or within 42 days of harvest.				
Annual spurge, barnyardgrass, carpetweed, crabgrass, crowfoot grass, Florida pusley, foxtails, goosegrass, johnsongrass from seed, lambsquarters, panicums, pigweed, purslane, signalgrass.		Pendime-thalin	Prowl 3.3 EC & generics	HRAC Group K1.
	Coarse	0.74-0.99	1.8 – 2.4pt	PPI only
	Medium	0.74-1.24	1.8 - 3.0 pt	
	Fine	0.99-1.24	2.4 - 3.0 pt	
	Coarse	0.50 – 0.74	1.2 – 1.8 pt	Layby only
	Medium	0.74 – 0.99	1.8 – 2.4 pt	
	Fine	0.74 – 0.99	1.8 – 2.4 pt	
			Prowl H_20 & generics	
	Coarse	0.95	2.0 pt	PPI only
	Medium	0.95 – 1.19	2.0 – 2.5 pt	
	Fine	1.19	2.5 pt	
	Coarse	0.71	1.5 pt	Layby only
	Medium	0.95	2.0 pt	
	Fine	0.95	2.0 pt	
Remarks: Consult specific product labels for details such as application rates. Higher rates may be recommended for silt and silt loam soils. *Rates are for broadcast application and must be adjusted for banded sprays based on the width of the intended spray band and soil texture.* Pendimethalin products should not harm transplanted tobacco if applied according to directions and under normal growing conditions, but can temporarily retard growth under stressful conditions (cold/wet to hot/dry weather). Layby applications should be made as a directed spray in a 16 to 24 inch band centered between rows. Spray contacting tobacco leaves may cause deformations. Crop injury may result if winter wheat or barley are no-till planted in the fall after spring application of pendimethalin products. Don't feed forage or graze livestock for 75 days after planting wheat or barley in pendimethalin-treated soil.				

WEED CONTROL IN FLUE-CURED TOBACCO FIELDS (continued)

Weed Problems	Soil Texture	Chemical Lbs Active Ingredient/A	Product per Acre	Applic. Method
Groundcherry, hairy galinsoga, jimsonweed, lambsquarters, morningglory (except pitted), nutsedge, pigweed, prickly sida, Pennsylvania smartweed. Suppresses most grasses, foxtail, panicums, cocklebur, signalgrass, spurges. Check label for uncommon weeds.		sulfentrazone	Spartan 4F & generics	After bedding, before transplant. HRAC Group 14.
	Coarse			
	<1.5%OM	0.14-0.19	4.5-6.0 fl oz	
	1.5-3%OM	0.19-0.25	6.0-8.0 fl oz	
	>3%OM	0.25-0.32	8.0-10.1 fl oz	
	Medium			
	<1.5%OM	0.19-0.25	6.0-8.0 fl oz	
	1.5-3%OM	0.25-0.32	8.0-10.1 fl oz	
	>3%OM	0.32-0.38	10.1-11.8 fl oz	
	Fine			
	<1.5%OM	0.25	8.0 fl oz	
	1.5-3%OM	0.32	10.1 fl oz	
	>3%OM	0.38	11.8 fl oz	

Remarks: %OM = % organic matter. Consult specific product labels for details such as application rates, and apply only as specified on the label. Do not apply to soils classified as sands with less than 1% 0.M. and shallow ground-water. *Most tobacco fields in Virginia contain coarse to medium textured soils.* Do not impregnate on fertilizer. Apply to soil surface after field has been prepared for planting. Apply within 14 days of transplanting, **after** beds are knocked down for planting. **Do not** apply at or after transplanting. Do not disturb treated soil below a 2 inch depth. *Crop injury can occur when incorporation is poor, transplants are set too shallow, or heavy rain falls near transplanting.* **Do not** apply a sulfentrazone product more than once per season. Do not seed small grains within 4 months of application. Do not plant cotton or canola within 18 months of use.

WEED CONTROL IN FLUE-CURED TOBACCO FIELDS (continued)

Weed Problems	Soil Texture	Chemical Lbs Active Ingredient/A	Product per Acre	Applic. Method
Hairy galinsoga, goosegrass, groundcherry, jimsonweed, lambsquarters, morning-glory, wild mustard, nightshade, nutsedge, orchardgrass, pigweed, prickly sida, broadleaf signalgrass, Pennsylvania smartweed.	Coarse	sulfentrazone + carfentrazone	Spartan Charge	Burndown, preplant surface application, PPI. Both active ingredients are HRAC Group 14.
	<1.5%OM	0.14 – 0.19 + 0.016 – 0.021	5.7 – 7.6 fl oz	
	1.5-3%OM	0.19 – 0.25 + 0.021 – 0.028	7.6 – 10.2 fl oz	
	>3%OM	0.25 – 0.32 + 0.028 – 0.035	10.2 – 12.8 fl oz	
	Medium			
	<1.5%OM	0.19 – 0.25 + 0.021 – 0.028	7.6 – 10.2 fl oz	
	1.5-3%OM	0.25 – 0.32 + 0.028 – 0.035	10.2 – 12.8 fl oz	
	>3%OM	0.32 – 0.38 + 0.035 – 0.042	12.8 – 15.2 fl oz	
	Fine			
	<1.5%OM	0.25 + 0.028	10.2 fl oz	
	1.5-3%OM	0.32 + 0.035	12.8 fl oz	
	>3%OM	0.38 + 0.042	15.2 fl oz	

Remarks*:* May be surface applied or preplant incorporated (less than 2 inches) from 14 days to 12 hr before transplanting. Beds must be knocked down before applying the product. If no incorporation, timely cultivation after transplanting is required for acceptable weed control. Tobacco may be re-planted in treated soil, but DO NOT retreat or re-bed field. *Do not use in tobacco greenhouses.* May be tank-mixed with liquid fertilizer and other registered herbicides, but a jar test prior to mixing is recommended to ensure compatibility. See label for instructions. Do not apply to soils classified as sands with less than 1 percent organic matter. *Splashing of treated soil onto young tobacco may cause localized burning*. Do not apply more than once per site per season. Do not seed small grains within 4 months of application, or plant cotton within 18 months or canola within 24 months. See label for other crop rotational *restrictions.*

PRECAUTIONARY AND RESTRICTION STATEMENTS

Read and follow all directions, cautions, precautions, and restrictions on each product label. Take labels seriously. This publication must not be used as the sole source of precautionary and restriction statements.

TOBACCO INSECT MANAGEMENT

T. David Reed, Extension Agronomist, Tobacco
Arash Rashed, Extension Entomologist

Several species of insects cause serious damage to tobacco in the field, the greenhouse, and in storage. Insects damage the roots, destroy the leaves and buds, and reduce leaf quality. Others transmit several important tobacco disease pathogens.

Although the use of insecticides is frequently necessary to prevent economic losses from occurring, the avoidance of unwanted residues of crop protection agents (CPAs) in the cured tobacco is critical. The application of insecticides can be especially problematic since they are generally applied in a manner to protect the entire plant and applications may be warranted after topping and thus near harvest time. Although an insecticide is labeled for tobacco and is applied according to label directions at the proper time, the grower is ultimately responsible for the residues present in the cured tobacco. Growers must also be mindful of any contract restrictions for CPA residues in tobacco to be sold. Of particular note is the prohibition of some contractors that acephate (Orthene) not be applied to tobacco. Residues of chlorantraniliprole (Coragen) are a concern to some buyers and thus contracts may prohibit the application of Coragen after layby to limit the occurrence of excessive residues. Additionally, residues of pyrethroid containing insecticides (Acenthrin, Besiege, Karate, Warrrior, Capture, etc.) have long been a problem and growers much use them with caution.

Integrated pest management (IPM) is the best way to manage insect pests on tobacco. It combines cultural, natural, and chemical controls to maintain insect pest populations below levels that cause economic damage to the crop. IPM promotes the use of insecticides only when needed. It emphasizes that a certain amount of insect damage does not reduce crop value enough to pay for the cost of treatment and that tobacco plants often compensate for insect damage. IPM helps to maximize profits, reduce pesticide residue levels, environmental contamination, and human exposure to pesticides. It also optimizes natural control provided by beneficial organisms.

Cultural controls

The following cultural practices help reduce insect infestations and decrease the need for insecticide applications on tobacco.

1. **Early land preparation.** Plow at least 4 weeks before transplanting to reduce cutworm infestations.
2. **Use recommended nitrogen rates**. Excessive rates of nitrogen fertilization may delay maturity and make tobacco a more favorable host for hornworms and aphids after topping.

3. **Adjustments in transplanting date.** Early-planted tobacco is often less favorable for aphids and hornworms, and more favorable for budworms and flea beetles. Late planted tobacco is highly susceptible to hornworm damage and may have reduced yield and quality.

4. **Destroy greenhouse transplants as soon as transplanting is completed to** keep aphids and other insects from developing high populations on the transplants and migrating to nearby tobacco fields.

5. **Manage field borders to reduce insect habitat**. Keep field margins clear of weeds and tall grass to reduce feeding, breeding, and over wintering sites for grasshoppers and other insects that move from these sites into tobacco fields. After tobacco is established and growing, leave uncut barriers between tobacco fields and hay fields that are infested with grasshoppers.

6. **Top tobacco in the button or early flower stage** to eliminate food sources for budworms and make the crop a less desirable host for aphids and hornworms.

7. **Obtain effective sucker control** to reduce food sources for hornworms, budworms, and aphids.

8. **Stalk cutting and root destruction** immediately after harvest reduces feeding and overwintering sites for hornworms, budworms, and flea beetles.

9. **Rotate tobacco with crops that are poor hosts of cutworms, white-fringed beetles, and wireworms.** Beware of cutworm and wireworm infestations following established grass sods and soybeans.

10. **Conservation tillage strategies including no-till and strip-till** reduce aphid and flea beetle populations, but may increase problems with cutworm, vegetable weevil, and slugs.

Natural Control

Beneficial organisms, including predators, parasites and pathogens, help control several insect pests on tobacco. For example, parasites often kill more than 80 percent of the budworms in tobacco fields, control similar to that obtained with the most effective foliar insecticides. Hornworms are parasitized by the larvae of *Cotesia congregata*, which feed inside the caterpillars. When these larvae mature, they emerge and form egg-like cocoons on the backs of the hornworms. Tiny wasps emerge from these cocoons in a few days, mate, and lay eggs in other hornworms. Stilt bugs are long-legged, slender, brown bugs that feed on hornworm and budworm eggs, aphids, and even small amounts of tobacco sap.

Aphids are attacked by the adults and larvae of several species of lady beetles, lacewings, syrphid fly larvae, and a bright red midge larva. A pathogenic fungi frequently controls aphids from July through September,

especially in wet seasons. Although beneficial insects are usually abundant on aphid-infested tobacco, they often have trouble keeping aphid populations below economic threshold levels.

To preserve beneficial insects, scout fields and use economic thresholds to time insecticide applications. Select insecticides with low impact on beneficials. These insecticides include: *Bacillus thuringiensis (Bt)*, chloranthraniliprole (Coragen), emamectin benzoate (Denim), pymetrozine (Fulfill), and spinosad (Blackhawk). Transplant water and tray drench applications of imidacloprid (Admire Pro and generics) and thiamethoxam (Platinum) are associated with increased problems with hornworms and budworms because they affect beneficial parasites that help control these pests.

Chemical control

Economic thresholds and field scouting are important tools in IPM. The economic threshold is that pest population or injury level that requires treatment with an insecticide to prevent economic damage to the crop. Fields are scouted at regular intervals (once a week) to determine when insect pests reach their thresholds. Foliar insecticides are applied when scouting indicates that one or more pests have reached their economic thresholds. Insecticides applied as foliar, transplant water, tray drench, and soil treatments are extremely important tools in an IPM program. Many cultural and natural controls help reduce insect outbreaks, but it is almost impossible to grow a top quality, high yielding tobacco crop without using some insecticides.

Insect Control on Transplants Produced in the Greenhouse

Almost all of the tobacco transplants used in Virginia is produced in greenhouses. So far, insects have caused minor problems in greenhouses. However, if recommended cultural practices are not carried out, several of the following pests could become serious problems.

- **Ants** can remove seeds from greenhouse trays and cause poor stands.
- **Crickets and earwigs** often destroy newly emerged tobacco seedlings, reducing stands and initial growth.
- **Shoreflies** are tiny flies that look like small houseflies. They are frequently numerous in greenhouses. Their larvae (tiny maggots) feed on young seedlings and may reduce stands during the first 2 weeks after germination.
- **Cutworms, crickets, adult and larval vegetable weevils,** and **slugs** usually feed on stems and leaves at night. Cutworms also cut off and destroy plants.

- **Crickets**, **cutworms**, **slugs**, and **yellow-striped armyworms** may destroy individual leaves on larger seedlings; this damage does little harm unless populations are very high.
- **Aphids** often build up high populations on tobacco seedlings in the greenhouse reducing plant vigor, and they may be carried to the field on infested plants.
- **Mice** remove the seeds from float trays seriously reducing plant stands. If stand loss is severe, the entire greenhouse may require reseeding.

Cultural controls in the greenhouse

Sanitation is the most important practice for managing insect pests in tobacco greenhouses. The following practices reduce the potential for insect infestations in greenhouses.

- Discard all unused plants and clean out the greenhouse immediately after transplanting has been completed.
- Keep the area in and around the greenhouse clean and free of weeds, decaying plant material, plastic, boards, metal, and other items that provide food and/or shelter for insects and other pests.
- Do not plant fall and winter gardens near the greenhouse. Aphids can survive on various vegetables and related weed species during the winter and develop winged forms that fly into greenhouses and establish colonies on tobacco seedlings. Cutworms, armyworms, vegetable weevils, and slugs may hide in these sites, migrate into the greenhouse, and injure tobacco seedlings.
- If greenhouses are used to produce other crops, a fallow period should be followed to keep pests from moving from those crops. Use extreme temperatures to kill insects hiding in the greenhouse. Close the greenhouse to increase the temperature in the summer and promote cold temperatures in the winter.

Clean the greenhouse thoroughly just before seeding in the spring. Seed the entire greenhouse at the same time.

Chemical control in the greenhouse

Acephate (Orthene and generics) is the only effective insecticide labeled for use on tobacco transplants grown in greenhouses (Table 1). It should be applied as a foliar spray when insect infestations are observed. Acephate provides good to excellent control of aphids, yellow-striped armyworms, cutworms, flea beetles, and vegetable weevils. It should not be applied in the irrigation water or in the float water. Acephate also gives effective control of ants when applied in the greenhouse before the float beds are set up. Excessive rates of acephate can injure or kill young seedlings.

Metaldehyde (Deadline Bullets) and iron phosphate (Suggo) baits control slugs and snails in the greenhouse. In the early evening, apply methaldehyde along walkways and the outside margins of the float beds. Do not apply baits directly to seedlings or use them in float water.

Mice should be controlled with traps or baits approved for their control.

Table 1. Insecticides for use on Transplants Grown in Greenhouses[a]

Insect	Insecticide and formulation	Rate per 1,000 sq ft
Aphids, cutworms, flea beetles	Acephate (Acephate AG) 75SP	1 tbs/3 gal of water (1 lb/acre)
	(Acephate) 97UP	¾ tbs/3 gal of water (¾ lb/acre)
	(Orthene) 97PE	¾ tbs/3 gal of water (¾ lb/acre)
Remarks and precautions: Apply as a spray. **Excessive rates of acephate can injury tender young plants. Do not apply through an irrigation system or in the float water.**		
Snails and slugs	Metaldehyde (Deadline Bullets) 4% bait	¼ to ½ lb
	Iron phosphate (Sluggo Bait) 1% bait	1 lb
Remarks and precautions: Slug damage is usually associated with shiny slime trails. Apply to alleys, walkways and vacant areas in late afternoon. **Do not apply to float water or directly on foliage** /They are deactivated by water.		
Ants	Acephate (Acephate AG) 75SP	1 oz/5 gal of water
	(Acephate) 97UP	¾ oz/5 gal of water
	(Orthene) 97PE	¾ oz/5 gal of water
Remarks and precautions: Apply 1 gal of mix to each mound area by sprinkling the mound until it is wet. Treat a 4 ft diameter circle around the mound. Treat only once during the season.		

[a] Always read and follow the directions on the insecticide label before use.

Insect Control on Newly Transplanted Tobacco

Wireworms

Wireworms are hard, white to yellowish-brown, wire-like larvae of click beetles. These pests live in the soil, feed on the roots, and tunnel the piths of young tobacco plants. This injury stunts plant growth, causing irregular stands and lower yields. Although wireworms feed throughout the growing season, the most serious damage occurs when the plants are becoming established during the first month after transplanting. Wireworms take 1 to 5 years to complete their life cycle. Most of this time is spent in the larval stage. The larvae emerge from eggs in the summer and fall, feed on the roots of various host plants, and overwinter into the next year. Larvae then feed on the newly transplanted tobacco seedlings. Pupation and emergence as adult click beetles occur in late spring and early summer.

Wireworms are most common in fields with a history of wireworm problems, or in those previously planted after grass sod, weeds, corn, clover, or small grains. In these situations, apply an insecticide labeled for their control (Table 2). Apply soil insecticides as broadcast treatments and incorporate them at least 2 weeks before transplanting. Another option is to use Admire Pro or generics, Platinum, or Brigadier at the wireworm rates as transplant water or transplant drench treatments. The most effective cultural practice is to use sturdy, healthy transplants that are less susceptible to wireworm damage than tender, young transplants. After wireworm damage has occurred, it is too late to apply an insecticide. Where damage is light to moderate, cultivation and irrigation may help injured plants recover and produce near normal yields.

Cutworms

Cutworms are active at night feeding on roots or leaves or cutting off entire plants. This injury can cause enough damage and stand loss to require replanting. However, since tobacco compensates well, less than five percent stand loss usually has no impact on yield. Cutworm infestations are very sporadic and difficult to predict, but they are most likely to occur in low, wet areas, and in weedy fields that are plowed less than a month before transplanting. Plowing fields in the early spring usually destroys the cover crop and weed hosts, and reduces cutworm populations. Scout fields for cutworm damage once or twice a week during the first month after transplanting to determine whether a remedial foliar treatment is needed (Table 11). For optimum control of this night-feeding pest, apply a foliar insecticide in late afternoon or early evening when five percent or more of the plants in a field have recent cutworm damage.

Soil-incorporated insecticides

Pretransplant soil applications of insecticides can provide effective control of cutworms and wireworms on tobacco. Several factors should be considered before selecting a soil insecticide.

- If a tobacco field has been in sod, weeds, or small grains during the previous year or has a history of wireworm problems, apply an insecticide for wireworm control.
- Brigade/Capture is a broadcast soil treatment for wireworm control (Tables 2 and 3).
- Admire Pro, Platinum, or Brigadier applied as transplant water or transplant drench treatments may be better choices for wireworm control because they also control aphids, thrips, and flea beetles (Tables 2, 4, and 5).
- Soil fumigants applied at the nematicide rate provide little control of insects in the soil because many insects are below the zone being fumigated.

Table 2. Ratings of soil, greenhouse tray drench, and transplant water treatments for control of insects on flue-cured tobacco.

Insecticide	Application method [1]	Leaf feeding insects			Soil insects		
		Aphids	Bud-worms	Flea beetles	Horn-worms	Cut-worms	Wire-worms
Acephate/ (Orthene 97 and generics)	TW	1	0	2	0	3	0
Imidacloprid (Admire Pro and generics) [2]	TW	5	0	2	0	0	3
Imidacloprid (Admire Pro and generics) [2]	TD	5	0	4	0	0	3
Bifenthrin (Brigade/ Capture and generics) [2]	TW PPI	0	0	0	0	3	3
Chlorantraniliprole (Coragen)	TPW	0	2	0	3	0	0
Cyantraniliprole 1.67F (Verimark)	TD	0	2	4	2	0	0
Cyantraniliprole 1.67F (Verimark)	TPW	0	2	4	2	0	0
Lambda cyhalothrin (Karate, Warrior II and others)	PPI	0	0	0	0	3	0
Thiamethoxam (Platinum) 2F	TW	5	0	3	0	0	3
Thiamethoxam (Platinum) 2F	TD	5	0	4	0	0	3

Ratings are based on a scale of 0 to 5 where 0 = not labeled or no control, 1 = poor control, 2 = fair control, 3 = good control, 4 = very good control, and 5 = excellent control.
[1] TW = Transplant water, TD = Transplant drench, PPI=Preplant soil incorporated.
[2] There are many generic formulations of imidacloprid and bifenthrin.

Table 3. Insects on Field Tobacco - Pretransplant Soil Treatments

Insect	Insecticide and formulation	Rate per acre
Wireworms	Lambda cyhalothrin (Warrior II with Zeon and generics) 2.1EC	1.92 fl oz
	Bifenthrin (Brigade/Capture and generics) 2EC	2.56 to 6.4 fl oz

Remarks and precautions: Make broadcast application 24 to 48 hours before bedding. Banded applications are usually less effective than broadcast applications. Bifenthrin is also registered for cutworm and flea beetle larvae. **These chemicals are restricted use**.

Table 4. Insects on Field Tobacco-Drench Application to Greenhouse Transplants

Insects	Insecticide and formulation	Rate per 1,000 plants
Aphids, flea beetles	Imidacloprid (Admire Pro) 4.6SC	0.5 to 0.6 fl oz
	(various generics) 2F	1.0 fl oz
	Thiamethoxam (Platinum) 2SC	0.5 to 0.8 fl oz
	(Platinum) 75SG	0.17-0.43 oz
Flea beetles, budworms, hornworms	Cyantraniliprole (Verimark SC)	10 to 13.5 fl. oz/acre
Wireworm, Thrips for suppression of tomato spotted wilt virus	Imidacloprid (Admire Pro) 4.6SC	0.6 to 1.2 fl oz
	(various generics) 2F	1.4 to 2.8 fl oz
	Thiamethoxam (Platinum) 2SC	0.6 to 1.3 fl oz
	() 2SC	0.6 to 1.3 fl oz
	(Platinum) 75SG	0.43 oz

Remarks and precautions: Apply as a drench to plants in trays prior to transplanting. Mix with water before application. Keep agitated or mix regularly to avoid settling in tank. Water the plants in the trays before treatment and again immediately after application using enough water to wash the residue from the foliage into the media. Transplant within 3 days.

[a] **Always read and follow the directions on the insecticide label before use.**

Table 5. Insects on Field Tobacco - Transplant Water Treatments

Insect	Insecticide and formulation	Rate
Flea beetles, cutworms, thrips, suppression of aphids	Acephate (Acephate AG) 75SP	1 lb/acre
	(Acephate) 97UP	0.75 lb/acre
	(Orthene) 97PE	0.75 lb/acre
	Bifenthrin (Brigade/Capture) 2EC	2.56 to 6.4 fl oz/acre
Flea beetles, budworms, hornworms	Cyantraniliprole (Verimark SC) 1.67F	10 to 13.5 fl. oz/acre
Aphids, flea beetles	Imidacloprid (Admire Pro) 4.6SC	0.5 to 0.6 fl oz/1,000 plants
	(various generics) 2F	1.0 fl oz/1,000 plants
	Thiamethoxam (Platinum) 2SC	0.5 to 0.8 fl oz/1,000 plants or (3 to 5 fl oz/acre)
	(Platinum) 75SG	0.17-0.43 oz/1,000 plants
Budworms, hornworms	Chlorantraniliprole (Coragen) 1.67SC	5.0 to 7.5 fl oz/acre
Remarks and precautions: Apply in at least 100 gallons of water per acre. Coragen must be applied uniformly in the root zone for optimum performance.		
Wireworms, thrips for suppression of tomato spotted wilt virus	Imidacloprid (Admire Pro) 4.6SC	0.8 to 1.2 fl oz/1,000 plants
	(various generics) 2F	1.4 to 2.8 fl oz/1,000 plants
	Thiamethoxam (Platinum) 2SC	0.8 to 1.3 fl oz/1,000 plants or (5 to 8 fl oz/acre)
	(Platinum) 75SG	0.43 oz/1,000 plants
Remarks and precautions: Admire Pro and Platinum usually give excellent season-long control of aphids. Apply treatments in at least 100 gal of water/acre. **Calibrate transplanters and allow tanks to run low before refilling.**		

[a] Always read and follow the directions on the insecticide label before use.

Remedial Control of Insects on Larger Tobacco

Scouting for Insects

Tobacco fields should be scouted at least once a week throughout the season to determine when insecticide applications are needed.

1. Take representative samples from the entire field except for the outside rows. As you walk through the field, try to sample areas throughout the field. Do not sample the same plants each week. Look for insect pests and their damage on at least 50 plants in a field (1 to 10 acres) by making counts and recording the data for 5 consecutive plants at 10 locations throughout the field. Select the plants before you see them. If a field is planted on two different dates or if there are great differences in plant size within the field, divide the field into two or more sections and sample each section separately. Take more samples in larger fields.
2. During the first 4 weeks after transplanting, check tobacco for feeding holes or missing, stunted, or cut plants. Cutworms, flea beetles, wireworms, and other insects may have damaged these plants.
3. Beginning 3 to 4 weeks after transplanting, aphids, budworms, flea beetles, and hornworms are the primary targets of an insect scouting program.
4. When a field is being scouted for insects that feed on tobacco foliage, individual plants should be examined and the observations recorded in a notebook as follows:

   a. Check the bud region for budworm damage. If damage is present, look carefully for budworms and the white cocoons of budworm parasites. Do not count plants without a live budworm.

   Examine the entire plant for hornworm damage, locate, and count the hornworms that are at least 1 inch long, and determine whether they have the white egg-like cocoons of *Cotesia congregata* on their backs. Check the undersides of the upper leaves for aphids and the upper surfaces of the middle and lower leaves for honeydew, flea beetles, flea beetle feeding holes, and splitworm mines.

   If you find an unidentified insect that appears to be damaging the crop, collect the insect and samples of its damage, and take them to a local Extension agent for identification. This is important because beneficial insects are often mistaken for pests and the misidentification of a pest may lead to the selection of the wrong insecticide for its control.
5. Tobacco fields should be treated when one or more insect pests meet or exceed the threshold levels shown in Table 6.

Table 6. Economic thresholds for various insects on tobacco.

Insect	Economic threshold	Time when insect is a problem
Aphids	50 or more aphids on any upper leaf of 5 of 50 plants.	4 weeks after transplanting to final harvest
Budworms	5 plants with one or more budworms per 50 plants until 1 week before topping.	3 weeks after transplanting to 1 week before topping
Cutworms	5 of 100 plants with recent cutworm damage.	1 to 4 weeks after transplanting
Flea beetles	4 beetles per plant on tobacco less than 3 weeks old and 60 beetles per plant on plants more than 4 weeks old.	Transplanting to 4 weeks after transplanting and from topping to final harvest
Grasshoppers	10 grasshoppers per 50 plants.	4 weeks after transplanting to final harvest
Hornworms	5 larvae (worms) at least 1 inch long per 50 plants. Count parasitized worms with the egg-like cocoons on their backs as 1/5 hornworm.	3 weeks after transplanting to final harvest. Can be a problem on air-cured tobacco in curing structures
Wireworms	Not determined	1 to 4 weeks after transplanting

Tobacco Budworms

Tobacco budworms feed in the buds of young tobacco plants causing many holes in the tiny developing leaves. As the leaves grow, the feeding holes become larger and give the plants a ragged, distorted appearance. Tobacco plants usually compensate for this damage so yield and quality may not be affected. However, budworms sometimes top the plants prematurely causing early sucker growth that may stunt the plants and require extra labor to remove the suckers. After the button stage, budworms rarely cause economic damage although they may burrow into the stalk. Apply foliar sprays for budworm control with 1 or 3 solid-cone or hollow-cone nozzles over each row using 40 to 60 psi to deliver 10 to 25 gallons of spray mixture per acre. The tobacco rows must be planted evenly so that the nozzles can be oriented directly over each row. See insecticide performance ratings in Table 7 and insecticide options for budworm control in Table 10. When checking tobacco for budworms, look on the leaves near the bud for the cocoons of two species of wasp that parasitize budworms. These cocoons are about ¼ inch long and white or grayish in color with two black bands or dots. These parasites provide good natural control of budworms on tobacco in Virginia.

Hornworms

Tobacco and tomato hornworms are large caterpillars (up to 4 inches long) that eat considerable amounts of tobacco leaf. Infestations may develop anytime from transplanting until harvest is completed, but damage is usually

most severe during June, August, and September. Predators also kill large numbers of small larvae that are less than 1 inch long. For this reason, hornworms less than 1 inch long are not considered when determining the economic threshold because they cause very little damage and have no effect on yield or quality. However, if a field has large numbers of hornworms less than 1 inch long, the field should be rechecked in 3 to 4 days. For optimum hornworm control, direct insecticide sprays to the upper one-half of the plants. See insecticide ratings in Table 7 and the labeled insecticides in Table 10. Several cultural practices help reduce the susceptibility of tobacco to hornworms. Early topping, early transplanting, effective sucker control, and recommended rates of nitrogen help reduce late-season infestations. When used on an area-wide basis, stalk cutting and root destruction immediately after harvest reduces overwintering hornworm populations.

Aphids

The green peach aphid is a severe pest of tobacco in Virginia. Under favorable conditions, aphid populations increase rapidly, doubling in size about every two days. High populations of aphids can cause serious reductions in yield and quality. As aphids feed, they excrete honeydew that contains the excess sugars provides a food source for a dark, sooty mold. The combination of sooty mold and honeydew interferes with curing, reduces leaf quality, and often remains on the leaves after aphids have been controlled. Aphids are most severe on field tobacco before topping, but they can be a problem after topping in some years. Watch for increases in aphid populations from early June to the end of August. Examine the undersides of leaves from all portions of tobacco plants to assess the extent of aphid infestation.

The following practices can be used to manage aphids on tobacco.

1. **Preventive control**

   Apply systemic insecticides before or at transplanting.
   Admire Pro or Platinum applied as transplant drench or transplant water treatments usually provide excellent season-long control of aphids (Table 2).

2. **Remedial control of aphids**

   Make remedial applications of a foliar insecticide at the economic threshold level before populations become too high (Table 3). This will make aphid control much easier for the rest of the season.

   Rotate insecticides for resistance management. The continuous use of the same insecticide year after year increases the chances that aphids and other pests will develop resistance to it. Rotating insecticides with different IRAC modes of action (MOA) reduces the chances that resistance will develop (Table 9). When applying several insecticides

for aphid control over the growing season, change from one MOA to another. Do not apply a neonicotinoid (group 4) such as Provodo, Actara, or Assail to tobacco already treated with another neonicotinoid (group 4) such as Admire or Platinum. Instead, apply Orthene (group 1B) or Fulfill (group 9).

Assess control after 3 or 4 days. It takes 1 to 3 days after application of most insecticides for the aphids to die. If control is not adequate, determine whether the weather conditions, spraying equipment, improper calibration, etc. contributed to the poor control. If another application is needed, apply an insecticide in another MOA group (Table 9).

Higher gallonage, higher sprayer pressure, drop nozzles, and spreader-stickers can improve coverage. For optimum aphid control with foliar insecticides, the sprays must come in contact with the aphids. Drop nozzles improve control if aphids are abundant on the undersides of the lower leaves.

Continue to scout the crop after satisfactory control is obtained. Aphid infestations may return to damaging levels and require additional insecticide applications.

3. Cultural control of aphids

Most cultural practices do not keep aphid populations below the economic threshold, but they can improve the effectiveness of foliar insecticides and reduce the need for insecticide applications after topping. Useful cultural practices include:

Avoid planting cole crops such as cabbage and turnips near greenhouses. These plants are sources of aphids that can infest tobacco plants early in the growing season.

Control aphids in greenhouses. Make sure seedlings are aphid-free before they are transplanted. Destroy greenhouse transplants immediately after transplanting is completed.

Transplant early. Early planted tobacco may become infested with aphids earlier, but it matures earlier and the aphids have less impact on early-planted tobacco than they do on tobacco planted near the middle of the recommended planting period.

Use recommended nitrogen rates on flue-cured tobacco. Too much nitrogen fertilizer causes the leaves to remain green later in the year and it promotes excessive sucker growth that favors aphid infestations.

Top early and control suckers. Aphid populations often decline rapidly after topping, especially in hot, dry weather. However, aphids may still reach damaging levels that require insecticide treatment.

Tobacco Flea Beetles

Adult tobacco flea beetles feed on the leaves and stalks of tobacco, while the tiny grubs feed on the roots. Extensive feeding on newly set transplants by both beetle stages may cause stunting and uneven stands. When checking tobacco fields for flea beetles, look for the characteristic shot-hole feeding damage, and then count the beetle as described earlier under field scouting. Flea beetle control ratings for systemic and foliar insecticides are listed in Tables 2 and 7, respectively. Insecticides for flea beetle control are listed in Tables 3, 4, 5, and 10. Harvesting at the normal time, and stalk cutting and root destruction immediately after the last harvest are the most effective cultural practices for reducing overwintering flea beetle populations and the resulting damage the next year. Nitrogen deficient tobacco appears to be more susceptible to flea beetle damage after topping.

Flea beetles are difficult to control after topping because most insecticides that can be used at this time provide only short residual control while flea beetles emerge from the soil over an extended period of time.

Managing thrips to control tomato spotted wilt virus

The tobacco thrips, *Frankliniella fusca,* is the primary vector of the tobacco pathogen, tomato spotted wilt virus (TSWV). TSWV caused moderate stand reductions in tobacco fields in parts of Virginia in 2002 but it has been a minor problem since then. Foliar treatments for thrips control are not effective for managing TSWV after the disease is observed in the field. However, tray drench or transplant water applications of Admire Pro or generic forms of imidacloprid and Platinum suppress TSWV. Tray drenches are more effective than transplant water treatments.

Tobacco splitworm

The tobacco splitworm or potato tuberworm, a leaf-mining caterpillar is sometimes a late season problem on tobacco. Splitworms live in tunnels or mines that appear as brown, tan, or grayish, translucent blotches on the leaves. Splitworms can also feed in the midvein and stalk. Old mines turn brown and brittle and may destroy over 50 percent of the leaf. Although the mines are most common on the lower leaves, they can occur on any leaf. Splitworm damage increases the amount of dead leaf tissue and may reduce crop yield and value. Since splitworms feed within the leaves, they are difficult to control with insecticides. Currently, only Coragen is registered for splitworm control on tobacco. However, Denim, Blackhawk, and acephate applied in high volumes of water may provide fair to good control. Denim was the most effective treatment for splitworms in one trial in Virginia.

Irish potatoes should not be planted or stored near tobacco fields because they can be an important source of this pest in tobacco. Since splitworms continue to develop inside the leaves after they are harvested, removing infested leaves and dropping them on the ground will not reduce the problem and may make it worse. Air-cured and fire-cured tobacco stalks are also a

source of overwintering splitworm moths so they should not be discarded near tobacco fields.

Insecticide Application Methods

Apply insecticides properly for optimum insect control. On small tobacco, obtain effective control by directing one solid-cone or hollow-cone nozzle per row to the bud. Operate equipment at 40 to 60 psi, do not exceed 5 miles per hour, and use at least 6 to 8 gallons of finished spray per acre. After tobacco is 2 ft. tall, use one or three nozzles per row. If three nozzles are used, orient the two side nozzles at 45 degree angles toward the upper $^1/_3$ of the plant. Use 20 to 50 gallons of spray mixture per acre at 40 to 60 psi. Set the nozzles 8 to 12 inches above the tobacco. Drop nozzles oriented to the undersides of the leaves and used in combination with one or three nozzles over the row may improve aphid, splitworm, and flea beetle control. Plant tobacco uniformly so that the space between rows is constant. This makes it easier to orient the spray nozzles over the plants during the spraying operation.

Table 7. Rating of foliar insecticides for control of common insect pests on flue-cured tobacco.

Insecticide	Aphids	BW[1]	CW[1]	FB[1]	GH[1]	HW[1]
Actara (thimethoxam)	4	0	0	4	0	0
Assail / **Anarchy** (acetamiprid)	4	1	0	4	0	3*
Besiege (Chloranthiliprole and Lambda cyhalotrin)	1	4	3	3	3	5
Blackhawk (Spinosad)	0	4	0	0	0	4
Brigade / **Capture** (Bifenthrin)	3	3	4	3	3	5
B.t.	0	2	0	0	0	5
Coragen (Chloranthiliprole)	0	4	0	0	0	5
Denim (Emamectrin benzoate)	0	4	0	0	0	4
Exirel Cyantraniliprole)	0	4	0	4	0	4
Fulfill (Pymetrozine)	3	0	0	0	0	0
Karate / **Warrior** (Lambda cyhalotrin)	1	3	3	3	3	5
Orthene / **Acephate** (Acephate)	4	2	4	2	4	5
Provado (Imidacloprid)	4	0	0	3	0	0
Steward (Indoxacarb)	0	4-	0	4	0	5

[1] BW = Budworm; CW = Cutworm; FB = Flea Beetle; GH = Grasshopper; HW = Hornworm.

Rating is as follows: 0 = not labeled, 1 = poor, 2 = fair, 3 = good, 4 = very good, 5 = excellent. *effective, but not labeled.

[a] Always read and follow the instructions on the insecticide label before use.

Table 8. Restricted entry intervals (REI) and preharvest intervals (PHI) for various insecticides used on flue-cured tobacco in Virginia.

Insecticide	Restricted entry Intervals (REI)	Preharvest interval (PHI)
Foliar treatments	**(hours)**	**(days)**
Acephate (Orthene/Acephate AG/Acephate UP)	24	3
Acetamiprid (Assail) 70WP, 30WG	12	7
Bacillus thuringiensis (Agree/Crymax/Dipel/ Javelin/XenTari)	4	0
Bacillus thuringiensis (Lepinox)	12	0
Bifenthrin (Brigade/Capture)	12	Do not apply after layby
Bifenthrin + imidacloprid (Brigadier)	12	Do not apply after layby
Chlorantraniliprole (Coragen)	4	1
Emamectin benzoate (Denim)	12	14
Imidacloprid (Nuprid/Provado) 1.6F	12	14
Indoxacarb (Steward)	12	14
Lambda-cyhalothrin (Karate/Warrior 1CS)	24	40
Pymethozine (Fulfill)	12	14
Spinosad (Blackhawk)	4	3
Thiamethoxam (Actara))	12	14
Soil treatments		
Bifenthrin (Brigade/Capture)	12	NA
Metaldehyde (Deadline Bullets)	12	NA
Greenhouse seedling drench or transplant water treatments		
Acephate (Orthene/Acephate)	24	NA
Bifenthrin (Brigade/Capture)	12	NA
Chlorantraniliprole (Coragen)	4	NA
Cyantraniliprole (Verimark SC)	4	NA
Imidacloprid (Admire Pro and generics)	12	NA
Lambda-cyhalothrin (Warrior/Karate)	12	NA
Thiamethoxam (Platinum) 2F	12	NA

Following the PHI for an insecticide application does not ensure that residues on the cured tobacco will be acceptable. Growers are ultimately responsible for residues and must heed contract restrictions for specific insecticides and consider using an insecticide that has the least residue concern. The use of acephate, pyrethroids, and Coragen should be considered carefully.

Minimizing Insecticide Residues

Pesticide residues are an important factor in the quality of cured tobacco that can cause some contractors to reject your crop. The following points help to minimize pesticide residues on the marketed crop.

- **Do not use any insecticides not labeled for use on tobacco.**
- **Do not use carbaryl (Sevin), chlorpyrifos, flubendiaminde (Belt) endosulfan, or methomyl (Lannate).** Some companies specify in their contacts chemicals that must not be used on the crop that they purchase.
- **Follow the preharvest intervals closely.** The pyrethroids, bifenthrin (Brigade) and lambda-cyhalothrin (Karate/Warrior) have very long preharvest intervals. Bifenthrin should not be applied after layby and lambda-cyhalothrin has a 40-day preharvest interval. Some companies are concerned about Orthene (Acephate) residues. Orthene should be applied as far from harvest as possible. **Use insecticides with short preharvest intervals during the harvest period.** *Bacillus thuringiensis* (Bt) and Blackhawk are good options for hornworms,

Resistance Management

The Insecticide Resistance Action Committee (IRAC) has grouped insecticides into mode of action (MOA) groups that are listed on many of the insecticide labels (Table 9). Avoid using insecticides within the same MOA group time after time. Instead, switch to an insecticide in another MOA group. This reduces the chances that an insect will develop resistance and help preserve the insecticides registered for tobacco.

Table 9. Tobacco insecticides by group and mode of action (MOA) for resistance management.

Group #	Mode of action	Chemical sub-group or active ingredient	Product name
1B	Acetylcholine esterase inhibitors	Organophosphates	Orthene
3	Sodium channel modulators	Pyrethroids, Pyrethrins	Brigade/Capture Karate/Warrior
4	Nicotinic Acetylcholine receptor agonists / antagonists	Neoicothinoids	Actara, Admire Pro, Assail, Platinum, Provado
5	Nicotinic Acetylcholine receptor agonists	Spinosyns	Blackhawk
6	Chloride channel activators	Avermectins	Denim
9	Selective feeding blockers	Pymetrozine	Fulfill
11	Microbial disruptors of insect midgut membranes	*Bacillus thuringiensis* var. *kurstaki, Bacillus thuringiensis* var. *tenebrionenses*	Dipel, etc.
22	Voltage dependent sodium channel modulators	Indoxacarb	Steward
28	Ryanodine receptor inhibitor	Chlorantraniliprole Cyantraniliprole	Coragen Exirel Verimark

Insect management on organic tobacco.

The number of insecticides available for use on organic tobacco is very limited and many of those provide marginal control of the target pests. Many of the approved materials are much less effective and provide shorter residual control than non-organic products. The Organic Materials Registry Institute (OMRI) lists materials that are available for use on organic tobacco. Many of the approved materials are much less effective and provide shorter residual control than synthetic insecticides. Many OMRI approved insecticides are expensive.

Aphids are the most challenging insect pest in organic tobacco because the insecticides labeled for their control provide very little control or there is limited information on their efficacy on tobacco. Dipel (Bacillus thuringensis and generics) has been used in conventional tobacco production for many years. It gives good control of hornworms and fair control of budworms when applied as a spray (DF) and the 10G formulation applied directly to the bud gives excellent budworm control. Pyganic gives good control of flea beetles, while the azadractin material (Aza-Direct and GOS Neem T-Way) provide fair control.

Organic growers may use several cultural practices to help manage insects on their crop. Crop rotation and early soil preparation help reduce problems with cutworms and may also help with wireworm control. Growers can plant sunflowers and buckwheat around field margins and in skip rows to attract beneficial insects and to act as barriers to some insect pests.

A PRECAUTIONARY STATEMENT ON PESTICIDES

Pesticides must be used carefully to protect against human injury and harm to the environment. Diagnose your pest problem, and select the proper pesticide if one is needed. The information presented here is not a substitute for pesticide label information. Follow label use directions, and obey all federal, state, and local pesticide laws and regulations.

Table 11. Insects on Field Tobacco - Foliar Treatments[a,b]

Insect	Insecticide and formulation	Rate per acre
Aphids	Acephate (Acephate AG) 75SP	2/3 to 1 lb
	(Acephate) 97UP	½ to ¾ lb
	(Orthene) 97PE	½ to ¾ lb
	Remarks and precautions: MOA = 1B. Apply as a spray in 10 to 50 gal/acre. Use highest rate for high populations. If tobacco is large and aphids are established on the lower leaves, drop nozzles that orient spray to undersides of leaves improve control. Prime before treating. **Acephate Residues: Residues of acephate are a concern and application may be prohibited by some contracts.**	
	Acetamiprid (Assail) 70WP	0.6 to 1.7 oz
	(Assail) 30SG	1.5 to 4.0 fl oz
	Remarks and precautions: MOA = 4. Apply as a spray in at least 20 gal/acre. Do not apply to tobacco already treated with imidaclorpid (Admire Pro, Provado,) or thiamethoram (Platinum) (Actara).	
	Bifenthrin (Brigade/Capture) 2EC	2.56 to 6.4 fl oz
	Remarks and precautions: MOA = 3. **Restricted use.** Do not apply after layby.	
	Bifenthrin + imidaclorpid (Brigadier) 1 + 1EC	3.8 to 6.4 fl oz
	Remarks and precautions: MOA = 3 for bifenthrin and 4 for imidaclorpid. **Restricted use.** Do not apply after layby.	
	Imidacloprid (Provado) 1.6F	2 to 4 fl oz
	(Nuprid and other generics) 1.6F	2 to 4 fl oz
	Remarks and precautions: MOA = 4. Apply as spray. **Do not apply to tobacco treated with Admire Pro, Assail, Platinum, or Provado.**	
	Pymetrozine (Fulfill) 50WG	2 ¾ oz
	Remarks and precautions: MOA = 9. Do not apply more than twice or 5½ oz/acre/year. Allow 7 days between applications.	
	Thiamethoxam (Actara) 25WDG	2 to 3 oz
	Remarks and precautions: MOA = 4. Do not apply to tobacco already treated with Platinum, Admire Pro, Assail, or Provado. Apply only once during the growing season.	

Table 11. Insects on Field Tobacco - Foliar Treatments (Cont'd)[a]

Insect	Insecticide and formulation	Rate per acre
Armyworms (beet, fall and yellowstripped)	Bifenthrin (Brigade/Capture) 2EC	4.0 to 6.4 fl oz
	Remarks and precautions: MOA = 3. **Restricted use.** Do not apply after layby.	
	Emamectin benzoate (Denim) 0.16EC	6 to 12 fl oz
	Remarks and precautions: MOA = 6. **Restricted Use**. Apply in sufficient water for through coverage.	
	Lambda-cyhalothrin (Warrior) 1CS	1.9 to 3.8 fl oz
	(Karate with Zeon, Warrior II) 2.1SC	0.96 to 1.92 fl oz
	Remarks and precautions: MOA = 3. **Restricted Use**. Apply as a spray. Observe the 40-day preharvest interval.	
	Orthene is labeled for armyworms on other crops.	
Budworms	Acephate (Acephate AG) 75SP	1 lb
	(Acephate) 97UP	¾ lb
	(Orthene) 97PE	¾ lb
	Remarks and precautions: MOA = 1B. **Acephate Residues: Residues of acephate are a concern and application may be prohibited by some contracts. Acephate is of limited effectiveness.**	
	Bacillus thuringiensis (Bt)	
	(Agree) WG	1 to 2 lb
	(Crymax) WG	½ to 2 lb
	(Dipel) DF	½ to 1 lb
	(Dipel) ES	1 to 2 pt
	(Dipel) 10G	5 to 10 lb
	(Javelin) WG	1 to 1 ¼ lb
	(XenTari) WDG	½ to 2 lb
	Remarks and precautions: MOA = 11. Apply as a spray. **Do not allow diluted sprays to stand in the sprayer more than 12 hours**. Bt sprays give fair control of budworms. Approved for organic tobacco. MOA=11.	
	Bifenthrin ((Brigade/Capture) 2EC	4.0 to 6.4 fl oz
	Remarks and precautions: MOA = 3. **Restricted use.** Do not apply after layby.	

Table 11. Insects on Field Tobacco - Foliar Treatments (Cont'd)

Insect	Insecticide and formulation	Rate per acre
Budworms (cont'd)	Chlorantraniliprole (Coragen) 1.67SC	5 fl oz
	Remarks and precautions: MOA = 28. Make no more than 4 applications per acre per season. Do not use an adjuvant with Coragen. **Residues of Coragen are a concern and some contracts may limit residues. Do not apply after layby.**	
	Emamectin benzoate (Denim) 0.16EC	8 to 12 fl oz
	Remarks and precautions: MOA = 6. **Restricted Use**. Apply in sufficient water for through coverage. Apply before damaging infestations occur.	
	Indoxacarb (Steward EC)	9.2 fl oz
	Remarks and precautions: MOA=22.	
	Lambda-cyhalothrin (Karate/Warrior) 1CS	1.9 to 3.8 fl oz
	(Karate with Zeon, Warrior II) 2.1SC	0.96 to 1.92 fl oz
	Remarks and precautions: MOA = 3. **Restricted Use**. Apply as a foliar spray after field scouting indicates the population has reached the economic threshold. **40-day preharvest interval.**	
	Spinosad (Blackhawk)36WG	1.6 to 3.2 oz
	Remarks and precautions: MOA = 5. Use higher rates for large larvae or high infestations. Use at least 20 gal of water per acre.	
	[a] Always read and follow the insecticide label before use.	
Cutworms	Acephate (Acephate AG) 75SP	1 lb
	(Acephate) 97UP	¾ lb
	(Orthene) 97PE	¾ lb
	Remarks and precautions: MOA = 1B. Apply as a spray overtop of plants in affected areas when 5% of plants are injured by cutworms. Make application during late afternoon using at least 25 gal of spray per acre. **Residues of acephate are a concern and application may be prohibited by some contracts.**	
	Lambda-cyhalothrin Karate (Warrior) 1CS	1.9 to 3.8 fl oz
	(Karate with Zion, Warrior II) 2.1SC	0.96 to 1.92 fl oz
	Remarks and precautions: MOA = 3. **Restricted Use**. Apply in the late afternoon when cutworms are causing damage. Do not apply within 40 days of harvest.	
	Bifenthrin (Brigade/Capture)	4.0 to 6.4 fl oz
	MOA=3A. **Restricted Use.** Apply during the late afternoon. Do not apply after layby.	
	Bifenthrin + imidacloprid (Brigadier)	5.1 to 6.4 fl oz
	MOA=3A and 4. **Restricted Use.** Apply during the late afternoon. Do not apply after layby.	

Table 11. Insects on Field Tobacco - Foliar Treatments (Cont'd)

Insect	Insecticide and formulation	Rate per acre
Flea beetles	Acephate (Acephate AG) 75SP	2/3 lb
	(Acephate) 97UP	½ lb
	(Orthene) 97PE	½ lb
	Remarks and precautions: MOA = 1B. Apply as a spray. Prime before treating. **Acephate Residues: Residues of acephate are a concern and application may be prohibited by some contracts. Acephate is of limited effectiveness.**	
	Acetamiprid (Assail) 70WP	1.1 to 1.7 oz
	(Assail) 30SG	2.5 to 4.0 fl oz
	Remarks and precautions: MOA = 4. Apply as a spray in at least 20 gal/acre. Do not apply to tobacco already treated with imidaclorpid (Admire Pro, Provado,) or thiamethoxam (Platinum) (Actara). Also provides fair control of hornworms.	
	Bifenthrin (Brigade/Capture) 2EC	4.0 to 6.4 fl oz
	Remarks and precautions: MOA = 3. **Restricted use.** Do not apply after layby.	
	Cyantraniliprole (Exeril)	13.5 to 20.5 fl oz
	Remarks and precautions: MOA = 28. Do not apply a total of 0.4 lbs per ac of cyantraniliprole products in one year	
	Imidacloprid (Provado) 1.6F	4 fl oz
	Remarks and precautions: MOA = 4. Apply as spray. **Do not apply to tobacco already treated with imidacloprid, acetimiprid, or thiamethoxam.**	
	Indoxacarb (Steward)	9.2 oz
	Remarks and precautions: MOA=22. Apply as spray.	
	Lambda-cyhalothrin	
	Karate (Warrior) 1CS	1.9 to 3.8 fl oz
	(Karate with Zion, Warrior II) 2.1SC	0.96 to 1.92 fl oz
	Remarks and precautions: MOA = 3. **Restricted Use**. Apply in sufficient water for coverage.	
	Thiamethoxam (Actara) 25WDG	2 to 4 oz
	Remarks and precautions: MOA = 4**.** Do not apply to tobacco already treated with Admire Pro, Assail, Platinum, or Provado. Apply only once during the growing season.	
	[a] Always read and follow the insecticide label before use.	

Table 11. Insects on Field Tobacco - Foliar Treatments (Cont'd)

Insect	Insecticide and formulation	Rate per acre
Grass-hoppers	Acephate (Acephate AG) 75SP	1/3 to 2/3 lb
	(Acephate) 97UP	¼ to ½ lb
	(Orthene) 97PE	¼ to ½ lb
	Bifenthrin (Brigade/Capture) 2EC	4.0 to 6.4 fl oz
	Remarks and precautions: MOA is 1B for acephate and 3 for bifenthrin. **Bifenthrin is restricted use.** Do not apply bifenthrin after layby. **Acephate Residues: Residues of acephate are a concern and application may be prohibited by some contracts. Acephate is of limited effectiveness.**	
	Indoxacarb (Steward)	9.2 oz
	Remarks and precautions: MOA = 22. Apply as spray.	
	Lambda-cyhalothrin (Warrior) 1CS	1.9 to 3.8 fl oz
	(Karate with Zion, Warrior II) 2.1SC	0.96 to 1.92 fl oz
	Remarks and precautions: MOA = 3. **Restricted Use**. Apply in sufficient water for coverage. There is a 40-day preharvest interval.	
Hornworms	Acephate (Acephate AG) 75SP	2/3 lb in water
	(Acephate) 97UP	½ lb
	(Orthene) 97PE	½ lb
	Remarks and precautions: MOA = 1B. Apply as a spray. Treat infested fields before worms are more than 1½ inches long. Direct insecticides toward the upper half of the plants. Prime before treatment**. Acephate Residues: Residues of acephate are a concern and application may be prohibited by some contracts.**	
	Bacillus thuringiensis	
	(Agree) WG	1 to 2 lb
	(Crymax) WG	½ to 2 lb
	(Dipel) DF	¼ to 1 lb
	(Dipel) ES	½ to 1 pt
	(Javelin) WG	1/8 to 1 ¼ lb
	Remarks and precautions: MOA = 11. Apply as a spray. Do not allow dilute sprays to stand in tank more than 12 hours. Dipel can be tank-mixed with maleic hydrazide (Royal MH-30).	
	Bifenthrin (Brigade/Capture) 2EC	4.0 to 6.4 fl oz
	Remarks and precautions: MOA = 3. **Restricted use.** Do not apply after layby.	

Table 11. Insects on Field Tobacco - Foliar Treatments (Cont'd)

Insect	Insecticide and formulation	Rate per acre
Hornworms cont'd	Chlorantraniliprole (Coragen) 1.67SC	5.0 fl oz
	Remarks and precautions: MOA = 28 **Residues of Coragen are a concern and some contracts may limit residues.**	
	Emamectin benzoate (Denim) 0.16EC	8.0 fl oz
	Remarks and precautions: MOA = 9. **Restricted Use**. Apply in sufficient water for through coverage before damaging infestations occur.	
	Indoxacarb (Steward EC)	9.2 fl oz
	Remarks and precautions: MOA= 22.	
	Lambda-cyhalothrin (Warrior) 1EC	1.9-3.8 fl oz
	(Karate with Zion, Warrior II) 2.1SC	0.96 to 1.92 fl oz
	Remarks and precautions: MOA = 3. **Restricted Use**. Apply as a spray. There is a 40-day preharvest interval.	
	Spinosad (Blackhawk)36WG	1.6 to 3.2 oz
	Remarks and precautions: MOA = 5. Apply as a spray in at least 20 gal of water per acre.	

Table 11. Insects on Field Tobacco - Foliar Treatments (Cont'd)

Insect	Insecticide and formulation	Rate per acre
Japanese beetles	Acephate (Acephate AG) 75SP	2/3 to 1 lb
	(Acephate) 97UP	½ to ¾ lb
	(Orthene) 97PE	½ to ¾ lb
	Remarks and precautions: MOA = 1B. Apply as a spray in 10 to 50 gal/acre. Prime before treating. **Acephate Residues: Residues of acephate are a concern and application may be prohibited by some contracts.**	
	Bifenthrin (Brigade/Capture) 2EC	4.0 to 6.4 fl oz
	Remarks and precautions: MOA = 3. **Restricted use.** Do not apply after layby.	
	Imidacloprid (Provado) 1.6F	4 fl oz
	Thiamethoxam (Actara) 25WDG	3 oz
	Remarks and precautions: MOA = 4A. Apply as a spray. Damage is usually less severe than it appears.	
	Lambda-cyhalothrin (Warrior) 1EC	1.9 to 3.8 fl oz
	(Karate with Zion, Warrior II) 2.1SC	0.96 to 1.92 fl oz
	Remarks and precautions: MOA = 3. **Restricted Use. Apply as a spray. There is a 40-day preharvest interval.**	
Stink bugs	Acephate (Acephate AG) 75SP	2/3 to 1 lb
	(Acephate) 97UP	½ to ¾ lb
	(Orthene) 97PE	½ to ¾ lb
	Remarks and precautions: MOA = 1B. Apply as a spray. Stinkbug injury is usually much less severe than it appears.	
	Bifenthrin (Brigade/Capture) 2EC	4.0 to 6.4 fl oz
	Remarks and precautions: MOA = 3. **Restricted use.** Do not apply after layby.	
	Lambda-cyhalothrin (Warrior) 1EC	1.9 to 3.8 fl oz
	(Karate with Zion, Warrior II) 2.1SC	0.96 to 1.92 fl oz
	Remarks and precautions: MOA = 3**. Restricted Use**. Apply as a spray. There is a 40-day preharvest interval.	

Table 11. Insects on Field Tobacco - Foliar Treatments (Cont'd)

Insect	Insecticide and formulation	Rate per acre
Thrips	Acephate (Acephate AG) 75SP	2/3 to 1 lb
	(Acephate) 97UP	½ to ¾ lb
	(Orthene) 97PE	½ to ¾ lb
	Remarks and precautions: MOA = 1A. Apply as a spray in 10 to 50 gal/acre. Use highest rate for heavy infestations or if control was poor with previous application. Prime before treating. Foliar applications for thrips control are not effective for reducing tomato spotted wilt virus after the disease is observed. [a] Always read the insecticide label before use.	
	Bifenthrin (Brigade/Capture) 2EC	4.0 to 6.4 fl oz
	Remarks and precautions: MOA = 3**. Restricted use.** Do not apply after layby.	
	Lambda-cyhalothrin	
	(Warrior) 1EC	1.9 to 3.8 fl oz
	(Karate with Zion, Warrior II) 2.1SC	0.96 to 1.92 fl oz
	Remarks and precautions: MOA = 3. **Restricted Use.** Apply as a spray. Foliar applications for thrips control are not effective for reducing tomato spotted wilt virus after the disease is observed. There is a 40-day preharvest interval.	
Tobacco splitworm/ potato tuberworm	Chlorantraniliprole (Coragen) 1.67SC	3.5 to 7.5 fl oz
	Remarks and precautions: MOA = 28. Make no more than 4 applications per acre per season. Do not use an adjuvant.	
Whitefringed beetle	No chemicals are currently registered for whitefringed beetle control on tobacco. In one trial, imidacloprid and thiamethoxam applied as tray drench and transplant water treatments provided good control.	
	Remarks and precautions: Cultural control: Rotate tobacco with grass crops. Control legumes and broadleaf weeds. Do not plant tobacco after legumes in fields with a history of white-fringed beetle infestations. **[a] Always read the insecticide label before use.**	

CURING TOBACCO

T. David Reed, Extension Agronomist, Tobacco

Flue-Cured Tobacco Curing

Curing flue-cured tobacco should be considered both an art and a science due subtle differences between cures as a result the tobacco itself (body, stalk position, moisture content, etc.), curing facilities, and weather conditions. It is difficult to use a set curing schedule because each barn of tobacco is different. Specific curing schedule are general guidelines to be used and individual cureds modified based on specific conditions.

The harvested leaves must be kept alive during the yellowing period so that desirable chemical and color changes can occur. At the same time, sufficient drying must take place so that when yellowing is completed the leaves will be thoroughly wilted. After the leaves reach the desired yellow color, temperature should be raised to kill the tissue and stop further chemical and color changes. If the leaves are killed too early by drying too fast or high temperatures, the color will remain green. After the desired color (lemon-orange) is achieved, the remainder of the cure is merely a matter of drying the leaf and stems to preserve the color.

Tobacco producers may follow different temperature and humidity schedules and still obtain a satisfactory cure. The exact temperature schedule is not critical as long as it is within reasonable limits. Mr. S. N. Hawks, retired Tobacco Extension Specialist at N. C. State University developed a `Simplified Curing Schedule' designed to reduce the complex curing procedure to its simplest terms. The three dry-bulb temperatures (100°F for yellowing, 130°F for leaf drying, and 160°F for stem drying) are well within safe ranges for each curing phase. Wet-bulb temperature for yellowing should be adjusted to fit the needs of the tobacco. The upper limits for leaf drying (105°F) and stem drying (110°F) are conservative.

The following points need to be remembered in following the Simplified Curing Schedule:

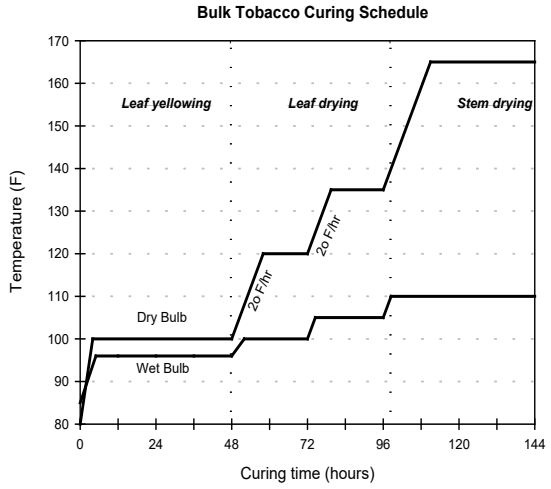
1. Remove all surface moisture from the leaves before beginning to yellow them. This may take up to 12 hours, depending on weather and tobacco conditions when the barn is filled. Lower leaves are often more difficult to yellow without developing soft rot.
2. Yellowing - Start heat at outside temperature and advance temperature 2°F per hour to 100°F. It may be necessary to open vents slightly during yellowing, but care must be taken to avoid setting green color by lowering relative humidity too much or drying too fast.

3. Maintain a dry bulb temperature of 100°F until all leaves are yellow. Provide enough ventilation so that when the leaves become yellow, those on the bottom tier will be completely wilted. Generally, a difference of 2 to 3°F between the wet- and dry-bulb reading should be maintained.

4. Leaf drying - When leaves are yellow and sufficiently wilted, the dry-bulb temperature should be advanced 2°F per hour to 130°F. Increase ventilation enough so that the wet bulb does not exceed 105°F. Toward the end of the leaf drying period it will usually be possible to reduce the amount of ventilation without exceeding 105°F on the wet bulb. A 130°F dry-bulb temperature should be maintained until all of the leaves on the lower two tiers are dry.

5. Stem drying - Dry-bulb temperature advanced 2°F per hour to 160°F and maintained until stems are dry. As long as the wet-bulb does not exceed 110°F, ventilation can be reduced. Toward the end of the cure the ventilators can be essentially closed to conserve fuel while drying stems.

A graphical representation of a bulk tobacco curing schedule provided by Drs. Boyette and Watkins of NCSU is shown on the following page. This differs only slightly from what is described above, except that there is a momentary holding of the dry bulb temperature at 120^0 F during leaf drying. This would provide for adequate removal of water from the tissue to avoid scalding or sweating of the tobacco.



The retrofitting of curing barns to indirect-fired heating focuses attention on heating efficiency and fuel consumption and this has only intensified with rising fuel prices. One measure of curing efficiency is calculation of pounds of cured tobacco per gallon of fuel. Although there will be varieties dependent on the senor, the barn, and the tobacco. A reasonable value would be 10 pounds of tobacco per gallon LPG or 13 pounds per gallon of fuel oil. Higher weights of cured tobacco per gallon of fuel would indicate greater curing efficiency.

Simply increasing the amount of tobacco loaded into the barn may not necessarily result in increased curing efficiency. The uniformity of how the barn is filled has a substantial impact on air movement throughout the barn. To obtain optimum curing efficiency, barn filling rates must be compatible with the airflow capacity on the barn. With development of box loader systems and load cells to weigh tobacco, growers have been able to realize improved curing efficiency resulting from more uniformly filled barns.

Tobacco has traditionally been cured solely with the use of a dry-bulb temperature or the thermostat setting controlling the burner. A relatively few growers have made use of a wet-bulb thermometer to cure by. This is possible due to the wealth of knowledge that growers have developed for curing tobacco, experience with barns that have been used for many years, and a feel for the ripeness characteristics of their tobacco. However, the use of a wet-bulb thermometer if likely to be the single most important practice that can be used to reduce fuel consumption when curing tobacco. With older barns, some amount of added insulation and repair will reduce heat loss and most new barns have improved insulation. Use of a wet-bulb thermometer will help reduce the amount of over ventilation of the barn. Over ventilation or opening dampers wider than necessary increase the drying rate of the tobacco and the burner fires more to heat the inflow of outside air. Various wet-bulb thermometers or hygrometers (wet-bulb and dry-bulb thermometers) are available and many designs or homemade units are also available.

The dry-bulb temperature is a measure of the air temperature within the barn and is controlled by the thermostat on the burner. In contrast, the wet-bulb thermometer measures the temperature of the leaf tissue and is controlled by the amount of ventilation or the size of the damper opening. The difference between the dry-bulb and wet-bulb temperatures determines the relative humidity within the barn and therefore the amount of drying that occurs. Maintaining a high wet-bulb temperature within each stage of curing will reduce ventilation and thus increase curing efficiency. (See graph of curing schedule on previous page).

Energy Efficient Curing Practices

More than 90 percent of the energy used for the production of flue-cured tobacco is used in the curing process. The following energy efficient curing practices should be followed to help reduce the cost of curing.

1. Regulate the barn using a wet-bulb thermometer. Ventilate only enough to hold humidity down (wet-bulb temperature); the wider the vent opening, the more fuel that is consumed. Automatic curing controllers utilize the added convenience of automatically controlling the damper opening.
2. Harvest only ripe tobacco; shorter curing times mean less heat loss and more efficient curing.
3. Load racks and boxes uniformly; uniform loading with no "tight spots" assures even drying and less energy use. Uniform barn loading reduces the length of the total cure.
4. Have burner set for optimum efficiency; periodic maintenance and adjustment is required for efficient operation.
5. Stop hot air leaks; check door gaskets and structure for cracks.
6. Assure an air seal around each rack or box; small cracks between boxes or racks reduces ventilation efficiency to a large degree.
7. Add insulation; well-insulated walls, roof and floor can save 10 to 20% of fuel consumed per cure. Insulate new barn pads with 1-inch thick insulation board.

Tobacco Specific Nitrosamines

Tobacco specific nitrosamines (TSNAs) are a principle group of carcinogens present in tobacco. Formation of these compounds is by two different pathways. In burley tobacco and fire-cured tobacco, TSNA are produced by naturally occurring microorganisms present on the leaves during curing. They feed upon natural compounds found in the tobacco leaf and produce TSNAs. Although curing conditions may be manipulated to modify TSNA levels, the curing season has a substantial input on TSNA levels found in stalk cut tobaccos. The higher temperatures and accelerated drying of the leaf greatly reduces the activity of microorganisms responsible for TSNA formation. However, the pathway for TSNA formation in flue-cured tobacco primarily involves nitrous oxides (NOx), produced as a by-product of combustion of LP or fuel oil, with specific alkaloids present in the tobacco. The use of heat exchangers or indirect-fired heating of curing barns has eliminated the introduction of NOx into the curing air space. However, heat exchangers must tested periodically to ensure their physical integrity and repaired if a leak is detected.

Barn Testing. Although NOx is the actual concern with a leaking heat exchanger, carbon dioxide (CO_2) will also be present in the curing air space. Carbon dioxide is measured because it is present in much higher amounts than NOx and measuring devices for CO_2 are much cheaper and portable than those for NOx. The procedure involves measuring the ambient CO_2 level (typically 350 to 500 ppm) in the barn with the burner off and then recording the increase in CO_2 above ambient in the barn after the burner runs for a sufficient time. Dampers are to be closed and the barn cannot contain green tobacco.

Interpreting CO_2 Meter Test Results:

- No increase in CO_2 above the ambient indicates that the entire system is intact at the time of testing.
- An increase in CO_2 less than 100 ppm indicates the present of a minimal leak somewhere in the furnace system.
- An increase in CO_2 between 100 and 200 ppm warrants further inspection of the furnace since a crack may be forming in the heat exchanger or a gap may be present in the exhaust stack.
- A doubling of the ambient CO_2 level indicates that a crack in the heat exchanger is likely.

Removal and examination of a heat exchanger for a crack can be a difficult procedure. High temperature (2500°F) caulking is available for minor repairs. Fortunately, the source of many leaks has been the exhaust stack. Any gap between the flue pipe and the heat exchanger or opening in the stack pipe may potentially allow exhaust gases to enter the curing chamber of the barn.

Although the use of indirect-fired curing removes NOx from the curing chamber, it is critically important to remember that microbial production of TSNAs may occur in flue-cured tobacco. It is important to remove any oxidized or barn rotted leaves from tobacco before baling and do not bale tobacco with excessive moisture or compression. Each of these factors will impact the TSNA level of tobacco.

CALIBRATION

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Proper calibration of both pesticide application equipment and fertilizer applicators is necessary to ensure that the intended amount of product is actually applied. This is especially important with pesticide sprayers to avoid potential crop injury from over application, to apply sufficient product to affect the target organism, and to avoid the added expense of over application.

Sprayer Calibration

The most convenient sprayer calibration procedure is the "1/128th acre" method. The basic principle is to determine the calibration distance to cover 1/128th of an acre based on the spacing of the spray tips. 1/128th of an acre is chosen because there are 128 oz. in a gallon and this allows for an easy determination of the application rate in gal. per acre with a measured output in ounces.

1/128th of an acre Calibration Procedure

1. Determine the calibration distance to travel according to nozzle spacing from the chart below.

2. Record the travel time over the calibration distance with equipment attached and operating in appropriate field conditions at the desired speed.

3. Collect spray material (water) from a nozzle for the amount of time from step 2. Operate sprayer with the same engine speed as used to determine travel time and the desired sprayer pressure.

Ounces collected per nozzle = gal. per acre

Calibration Distances for Various Nozzle Spacings

Spacing	Distance	Spacing	Distance
10 in.	408 ft.	30 in.	136 ft.
12 in.	340 ft.	36 in.	113 ft.
16 in.	255 ft.	40 in.	102 ft.
18 in.	227 ft.	42 in.	97 ft.
20 in.	204 ft.	44 in.	93 ft.
22 in.	186 ft.	46 in.	89 ft.
24 in.	170 ft.	48 in.	85 ft.

Example – For a broadcast boom with a nozzle spacing of 22 in. the calibration distance is 186 ft. The travel time with the sprayer in the field is found to be 32 seconds. Twenty five ounces of water is collected from one

nozzle for 32 seconds at the desired pressure so the application rate is 25 gal. per acre.

Note 1: When more than one nozzle is used per row with over-the-top applications such as sucker control and insecticide sprays, collect the output from each nozzles per row and combine for a total for the row (this is not a banded application). The nozzle spacing is considered to be the row spacing.

Note 2: For banded applications use the width of the spray band as the nozzle spacing. For example, with a 20 in. band with 48 in. row spacing, the travel distance is 204 ft. The treated acreage will be 42% of the acreage actually traveled (20 in. divided by 48 in. times 100).

Note 3: Transplanters may be calibrated using the 1/128th acre method. Pull the transplanter through the field and record travel time for the calibration distance based on transplanter row spacing, operating at the desired speed. Collect setter water from each unit for the corresponding travel time to determine application rate (ounces collected = gal/ac for setter water application rate).

Note 4: Although the output of individual spray nozzles is collected to determine application rate, the output of multiple nozzles should be collected and compared to each other to verify the uniformity of the spray application. Replace any spray tip that is more that 10% off the average of all the nozzles.

Greenhouse Sprayer Calibration Procedure

1. Determine the appropriate distance to travel for calibration according to nozzle spacing on boom.

Nozzle Spacing	Calibration Distance
12 in.	78 ft.
14 in.	67 ft.
16 in.	59 ft.
18 in.	52 ft.
20 in.	47 ft.
22 in.	43 ft.
24 in.	39 ft.

2. Determine calibration time to travel the distance in Step 1.
3. Collect output from one nozzle for the calibration time.
4. Divide the number of ounces collected by 10 to obtain application rate in gal. per 1000 sq. ft.

Since greenhouse spray booms are typically pushed by hand, it is important to choose a pace that is easy to maintain and duplicate.

Example – A 35 x 250 ft greenhouse (8750 sq. ft) is sprayed with a traveling boom having a nozzle spacing of 20 in. The calibration distance is 47 ft. and the travel time is determined to be 3 min. 45 sec. Water is run through the boom at the desired pressure and 54 oz. is collected from one nozzle. The application rate is 54 / 10 or 5.4 gal. per 1000 sq. ft.

Calibration of Fertilizer Application Equipment

Accurate application of the desired amount of fertilizer is essential to supplying the proper nutrition to a tobacco crop. Proper calibration of application equipment will better ensure that the proper amount of fertilizer is applied. The "1/100 acre" method is one the easiest calibration procedures and does not require calibration charts and calculations.

1) The first step is to determine the appropriate calibration distance based on your row spacing.

Row spacing	Calibration distance
48 in.	109 ft.
46 in.	114 ft.
44 in.	119 ft.
42 in.	124 ft.
40 in.	129 ft.
36 in.	134 ft.
32 in.	139 ft.

2) Collect fertilizer from the applicator over the calibration distance and weigh the fertilizer.

3) Multiply the amount of fertilizer collected times 100 to obtain the fertilizer application rate (lbs/acre).

With two outlets per row, fertilizer should be combined to obtain the application rate for the row.

Fertilizer should be collected separately from each row to determine the actual rate of each row.

Example - With a row spacing of 46 inches the calibration distance in 114 feet. If 7.25 lbs. of fertilizer is collected from both outlets of a row applicator then the application rate is 7.25 times 100 or 725 lbs/acre.

Individual rows of 2- or 4-row applicators should be within a 10 percent range of the intended rate. In the above example with 725 lbs/acre, an acceptable range would be 690 to 760 lbs/acre. Differences between rows

become more important with higher nitrogen fertilizers (8-8-24 vs 6-6-18) or when applying nitrogen sidedress fertilizers.

Plant Population Chart (plants per acre)

Plant Spacing	Row Spacing (in.)					
(in.)	36	40	42	44	46	48
16	10,890	9,801	9,334	8,910	8,523	8,168
17	10,249	9,225	8,785	8,386	8,021	7,687
18	9,680	8,712	8,297	7,920	7,576	7,260
19	9,171	8,254	7,860	7,503	7,177	6,878
20	8,712	7,841	7,467	7,128	6,818	6,534
21	8,297	7,468	7,112	6,789	6,493	6,223
22	7,920	7,128	6,789	6,480	6,198	5,940
23	7,576	6,818	6,493	6,198	5,929	5,682
24	7,260	6,534	6,223	5,940	5,682	5,445
25	6,870	6,273	5,974	5,702	5,454	5,227
26	6,702	6,031	5,744	5,483	5,245	5,026
27	6,453	5,808	5,531	5,280	5,050	4,840
28	6,223	5,601	5,334	5,091	4,870	4,667
29	6,008	5,408	5,150	4,916	4,702	4,506
30	5,808	5,227	4,978	4,752	4,545	4,356

For example: With a row spacing of 48 in. and a spacing of 22 in. between the plants within the row -- the plant population is 5940 plants per acre.

EPA Worker Protection Standards for Commonly Used Pesticides for Flue-Cured Tobacco 2023

T. David Reed, Extension Agronomist, Tobacco

The US-EPA Worker Protection Standard is a regulation that requires actions to be taken to protect agricultural workers from the risk of pesticide-related illness or injury. To protect your workers, you must be aware of the Worker Protection Standard (WPS) and know how to comply with its requirements. To plan effectively, you must also understand how compliance might affect your farming operation.

The Standard requires that employers provide for their workers and pesticide applicators in three areas. 1) Training on pesticide safety. Information about the specific pesticides used on the farm must be provided. Much of this information must be posted in a central location; including specifics on recent pesticide applications (location of application, name of the pesticide, EPA registration number and active ingredient, time and date of application, restricted entry interval, (REI) and the time when workers may reenter the field). 2) Protection against exposure must be ensured. Employers must provide personal protective equipment and be sure it is properly used and cleaned. They must also be sure that workers are warned about treated areas (through oral warning, posting of field, or both) and that workers do not enter treated fields during restricted entry intervals (with some very specific exceptions). This may require careful scheduling of pesticide application and field work so that they do not conflict. Personal protective equipment (PPE) requirements vary from pesticide to pesticide and may be different for applicator/handlers and mixer/loaders. Protective equipment is also required for entry into fields during the restricted-entry interval. Labels should be checked carefully for specific requirements. Restricted entry intervals also vary by pesticide, as stated on labels. 3) Employers must provide ways for their workers to mitigate or minimize the impacts of pesticide exposure. This includes making available decontamination sites and emergency assistance in case of exposure.

The following table lists products, registration numbers, common names, restricted entry intervals, and posting/notification requirements for commonly used pesticides and growth regulators labeled for tobacco. The label may include more detailed information regarding PPE requirements. The information in this table is presented in good faith as a **reference only**. This information does not take the place of the product label; changes to label information can occur without notice. ***Always read and follow label directions.*** The list does not contain all products labeled for use on tobacco, but should include the vast majority of products used on tobacco in Virginia.

DISCLAIMER: **The following information and worker protection standards are presented in good faith for your reference. This information does not take the place of the product label; changes to product label information can occur without notice.** ***Always read and follow label directions.***

Product Trade Name (common name) EPA Reg. No. Company Name	**Signal Word**	**Restricted Entry Interval (REI)[1]**	**Personal Protective Equipment (PPE)[2]** **Applicators and Other Handlers**	**To Enter Treated Area Within REI[3]**	**Worker Notification[4]** **Oral**	**Posted**
Acephate 90 WDG (acephate) EPA Reg. No. 34704-1051 Loveland Products **Acephate 97UP** EPA Reg. No. 70506-8 UPL NA Inc.	Caution	24 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks; chemical resistant headgear for overhead exposure	coveralls; waterproof gloves; shoes plus socks; chemical resistant headgear for overhead exposure	either	either
Actara (thiamethoxam) EPA Reg. No. 100-938 Syngenta Crop Protection	Caution	12 hrs.	long-sleeved shirt, waterproof gloves, shoes plus socks	coveralls, waterproof gloves, shoes plus socks	either	either
Actigard ® 50WG (acibenzolar-S-methyl) EPA Reg. No. 100-922 Syngenta Crop Protection	Caution	12 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves made of any waterproof material; shoes plus shoes	coveralls, chemical-resistant gloves made of any waterproof material shoes plus socks	either	either
Admire® Pro (imidacloprid) EPA Reg. No. 264-827 Bayer CropScience	Caution	12 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either
Agree® *(Bacillus thuringiensis var. aizawai* strain) EPA Reg. No. 70051-47 Certis USA	Caution	4 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks; protective eyewear; dust/mist filtering respirator	coveralls; waterproof gloves; shoes plus socks; protective eyewear	either	either

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2] Applicators and Other Handlers	Personal Protective Equipment (PPE)[2] To Enter Treated Area Within REI[3]	Worker Notification[4] Oral	Worker Notification[4] Posted
Agri-Mycin 17 (streptomycin sulfate) EPA Reg. No. 55146-96 Nufarm Americas Inc.	Caution	12 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves made of any waterproof material; shoes plus socks	coveralls over long-sleeved shirt and long pants; chemical-resistant gloves made of any waterproof material; shoes and chemical-resistant footwear	either	either
Agri-Mycin 50 (streptomycin sulfate) EPA Reg. No. 55146-98 Nufarm Americas Inc.	Caution	12 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves made of any waterproof material; shoes plus socks; protective eyewear; NIOSH-approved particulate respirator with N, R, or P filter.	coveralls over long-sleeved shirt and long pants; chemical-resistant gloves made of any waterproof material; shoes and socks; protective eyewear.		
Aim EC (carfentrazone) EPA Reg. No. 279-3241 FMC Corporation	Caution	12 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2] Applicators and Other Handlers	To Enter Treated Area Within REI[3]	Worker Notification[4] Oral	Posted
Aliette WDG Fungicide (aluminum tris (o-ethylphsophonate) EPA Reg. No. 264-516 Bayer CropScience	Caution	12 hrs.	long-sleeved shirt & long pants; waterproof gloves, shoes plus socks; protective eyewear	coveralls, waterproof gloves, shoes plus socks; protective eyewear	either	either
Alias ® 2F (imidacloprid) EPA Reg. No. 66222-203 ADAMA	Caution	12 hrs.	long-sleeved shirt and long pants, waterproof gloves, shoes plus socks, and chemical resistant headgear for overhead exposure	coveralls, chemical resistant gloves and shoes plus socks	either	either
Anarchy ® 30SG (acetamiprid) EPA Reg. No. 34704-1098 Loveland Products **Anarchy 70WP** EPA Reg. No. 34704-1096	Caution	12 hrs.	long-sleeved shirt and long pants, waterproof gloves, shoes plus socks, and chemical resistant headgear for overhead exposure	coveralls, chemical resistant gloves and shoes plus socks	either	either
Assail ® 30SG EPA Reg. No. 8033-36-70506 **Assail ® 70WP** EPA Reg. No. 8033-23-70506 UPL NA Inc.	Caution	12 hrs.	long-sleeved shirt and long pants, waterproof gloves, shoes plus socks, and chemical resistant headgear for overhead exposure	coveralls, chemical resistant gloves and shoes plus socks	either	either
Blackhawk (spinosad) EPA Reg. No. 62719-523 Dow AgroSciences	Caution	4 hrs.	long-sleeved shirt and long pants; shoes plus socks; chemical-resistant gloves	coveralls; chemical-resistant gloves; shoes plus socks	either	either

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE) [2] Applicators and Other Handlers	 To Enter Treated Area Within REI [3]	Worker Notification[4] Oral	 Posted
Boll Buster® (ethephon) EPA Reg. No. 34704-856 Loveland Products	Danger	48 hrs.	coveralls over short-sleeved shirt and short pants; waterproof gloves; protective eyewear; chemical resistant footwear plus socks; chemical resistant headgear for overhead exposures; chemical resistant apron when cleaning equipment	coveralls over short-sleeved shirt and short pants; waterproof gloves; protective eyewear; chemical resistant footwear plus socks; chemical resistant headgear for overhead exposures	yes	yes
Brigadier (bifenthrin + imidacloprid) EPA Reg. No. 729-3332 FMC Corporation	Warning	12 hrs.	long-sleeved shirt and long pants; shoes plus socks	coveralls, chemical-resistant gloves, such as Barrier Laminate or Nitrile rubber or Neoprene rubber or Vitron, and shoes plus socks	either	either
Capture LFR 1.5EC (bifentrin) EPA Reg. No. 279-3302 FMC Corporation	Warning	12 hrs.	long-sleeved shirt and long pants, chemical-resistance gloves, such as Barrier Laminate or Nitrile rubber or Vitron and shoes plus socks and protective eyewear	coveralls, chemical-resistant gloves, such as Barrier Laminate or Nitrile rubber or Neoprene rubber or Vitron, and shoes plus socks	either	either

Product Trade Name (common name) EPA Reg. No. Company Name	**Signal Word**	**Restricted Entry Interval (REI)[1]**	**Personal Protective Equipment (PPE) [2]** **Applicators and Other Handlers**	**To Enter Treated Area Within REI [3]**	**Worker Notification[4]** **Oral**	**Posted**
Command ® 3ME EPA Reg. No. 279-3158 FMC Corporation	Caution	12 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves, such as Barrier Laminate, Butyl or Nitrile rubber, or Viton; shoes plus socks.	coveralls; chemical-resistant gloves, such as Barrier Laminate, Butyl or Nitrile rubber or Viton; and shoes plus socks.	either	either
Coragen 1.67SC (chlorantraniliprole) EPA Reg. No. 352-729 DuPont	None	4 hrs.	long-sleeved shirt and long pants; shoes plus socks	shirt, pants; and shoes	either	either
Crymax® **(***Bacillus thuringiensis)* EPA Reg. No. 70051-86 Certis USA	Caution	4 hrs.	long-sleeved shirt and long pants; shoes plus socks; and dust/mist filtering respirator	coveralls; waterproof gloves; shoes plus socks; and protective eyewear	either	either

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE) [2] Applicators and Other Handlers	To Enter Treated Area Within REI [3]	Worker Notification[4] Oral	Posted
Deadline Bullets (metaldehyde) EPA No. 5471-507 Amvac	Caution	12 hrs.	long-sleeved shirt and long pants; shoes plus socks	long-sleeved shirt; shoes plus socks	either	either
Denim (emamectin benzoate) EPA Reg. No. 100-903 Syngenta Crop Protection	Danger	48 hrs.	coveralls worn over long-sleeved shirt and long pants, chemical-resistant gloves, chemical-resistant footwear plus socks, protective eyewear, chemical-resistant apron when cleaning equipment, mixing or loading.	coveralls over long-sleeved shirt and long pants, chemical-resistant gloves, chemical-resistant footwear plus socks.	either	either
Devrinol 2-XT (napropamide) EPA Reg. No. 70506-301 UPL NA Inc.	Danger	12 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves; shoes plus socks	coveralls; chemical-resistant gloves made of any waterproof material; shoes plus socks; protective eye wear.	either	either
Devrinol DF-XT (napropamide) EPA Reg. No. 70506-36 UPL NA Inc.	Caution	12 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves, shoes plus socks	coveralls; chemical-resistant gloves made of any waterproof material; shoes plus socks; protective eye wear.	either	either
Exirel (cyantraniliprole) EPA Reg No. 279-9615 FMC Corporation	Caution	12 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves, shoes plus socks	coveralls; chemical-resistant gloves made of any waterproof material; shoes plus socks; protective eye wear.	either	either

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2] Applicators and Other Handlers	Personal Protective Equipment (PPE)[2] To Enter Treated Area Within REI[3]	Worker Notification[4] Oral	Worker Notification[4] Posted
Dipel® DF (*Bacillus thuringiensis*) EPA Reg. No. 73049-39 Valent **Dipel® ES** EPA Reg. No. 73049-17 **Dipel 10G** EPA Reg. No. 73049-14	Caution	4 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks; dust/mist filtering respirator	coveralls; waterproof gloves; shoes plus socks	either	either
Drexalin Plus (flumetralin) EPA Reg. No. 19713-510 Drexel Chemical	Caution	24 hrs.	long-sleeved shirt and long pants; socks, shoes, and chemical-resistant gloves made of any waterproof material such as Viton or barrier laminate and chemical-resistant apron when cleaning equipment, mixing or loading	long-sleeved shirt and long pants, socks; shoes, and chemical-resistant gloves made of any waterproof material, chemical-resistant headgear for overhead exposure	either	either
Ethephon 6 (ethephon) EPA Reg. No. 66330-250 UPL NA Inc.	Danger	48 hrs.	coveralls over short-sleeved shirt and short pants; waterproof gloves; protective eyewear; chemical resistant footwear plus socks; chemical resistant headgear for overhead exposures; chemical resistant apron when cleaning equipment	coveralls over short-sleeved shirt and short pants; waterproof gloves; protective eyewear; chemical resistant footwear plus socks; chemical resistant headgear for overhead exposures	yes	yes
Fair 85® (C6 - C12 fatty alcohols) EPA Reg. No. 51873-7 Fair Products	Warning	24 hrs.	long-sleeved shirt and long pants; chemical resistant gloves such as Barrier Laminate or butyl rubber or nitrile rubber or neoprene or polyvinyl chloride or Viton; shoes plus socks; protective eyewear	coveralls; chemical resistant gloves such as Barrier Laminate or butyl rubber or nitrile rubber or neoprene or polyvinyl chloride or Viton; shoes plus socks; protective eyewear	either	either
Fair Plus® (maleic hydrazide) EPA Reg. No. 51873-2 Fair Products	Caution	12 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks; protective eyewear	coveralls; waterproof gloves; shoes plus socks; protective eyewear	either	either

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2] Applicators and Other Handlers	To Enter Treated Area Within REI[3]	Worker Notification[4] Oral	Posted
FireWall 17 WP (streptomycin sulfate) EPA Reg. No. 80990-4 AgroSource Inc.	Caution	12 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves made of any waterproof material; shoes plus socks; MSHA/NIOSH approved dust/mist respirator with any R, P, or HE filter	coveralls over long-sleeved shirt and long pants; chemical-resistant gloves made of any waterproof material; shoes plus socks	either	either
FluPro (flumetralin) EPA Reg. No. 400-600 UPL NA Inc.	Warning	24 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves made of any waterproof material such as nitrile, butyl, neoprene, or barrier laminate; chemical resistant footwear plus socks	long-sleeved shirt and long pants; chemical-resistant gloves made of any waterproof material such as nitrile, butyl, neoprene, or barrier laminate; chemical resistant footwear plus socks; protective eyewear	either	either
Forum *(dimethomorph)* EPA Reg. No. 241-427 BASF Ag Products	Caution	12 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves; shoes plus socks	long-sleeved shirt and long pants; chemical-resistant gloves; shoes plus socks	either	either

Product Trade Name (common name) EPA Reg. No. Company Name	**Signal Word**	**Restricted Entry Interval (REI)[1]**	**Personal Protective Equipment (PPE) [2]** **Applicators and Other Handlers**	**To Enter Treated Area Within REI [3]**	**Worker Notification[4]** **Oral**	**Posted**
FST-7® (C10 fatty alcohol and maleic hydrazide) EPA Reg. No. 51873-6 Fair Products	Danger	24 hrs.	long-sleeved shirt and long pants; chemical resistant gloves such as Barrier Laminate or butyl rubber or nitrile rubber or neoprene or polyvinyl chloride or Viton; shoes plus socks; protective eyewear	coveralls; chemical resistant gloves such as Barrier Laminate or butyl rubber or nitrile rubber or neoprene or polyvinyl chloride or Viton; shoes plus socks; protective eyewear	either	either
Fulfill® 50WDG (pymetrozine) EPA Reg. No. 100-912 Syngenta Crop Protection	Caution	12 hrs.	coveralls; chemical-resistant waterproof gloves, shoes plus socks	coveralls; chemical-resistant gloves waterproof, shoes plus socks	either	either

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2] Applicators and Other Handlers	Personal Protective Equipment (PPE)[2] To Enter Treated Area Within REI[3]	Worker Notification[4] Oral	Worker Notification[4] Posted
Leven-38® (C10 fatty alcohol and maleic hydrazide) EPA Reg. No. 19713-105 Drexel	Danger	24 hrs.	coveralls over short-sleeved shirt and short pants; waterproof gloves; chemical- resistant footwear plus socks; protective eyewear; chemical-resistant headgear for overhead exposure; chemical-resistant apron when cleaning equipment, mixing or loading	coveralls over short-sleeved shirt and short pants; chemical-resistant footwear plus socks; protective eyewear, chemical-resistant headgear for overhead exposure	either	either
Lorsban® 4E (chlorpyrifos) EPA Reg. No. 62719-220 **Lorsban Advanced** (chlorpyrifos) EPA Reg. No. 62719-591 Dow AgroSciences, LLC	Warning	24 hrs.	long-sleeved shirt and long pants; chemical resistant gloves; chemical resistant footwear plus socks, chemical resistant headgear for overhead exposure, a NIOSH approved dust-mist filtering respirator or NIOSH approved respirator with R, P, or HE filter	coveralls; waterproof and chemical-resistant gloves; chemical resistant footwear and chemical resistant headgear for overhead exposure	yes	yes
MetaStar 2E (metalaxyl) EPA Reg. 71532-91026 AgBiome Innovations.	Warning	48 hrs.	long-sleeved shirt & long pants; chemical resistant gloves, shoes plus socks; protective eyewear	coveralls; chemical-resistant gloves; shoes plus socks; protective eyewear	either	either
Nimitz (fluensulfone) EPA Reg. No. 66222-243 ADAMA	Caution	24 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves such as barrier laminate or Viton >14 mils; shoes plus socks	Not specified on label	either	either

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2] Applicators and Other Handlers	Personal Protective Equipment (PPE)[2] To Enter Treated Area Within REI[3]	Worker Notification[4] Oral	Worker Notification[4] Posted
Nuprid 2SC (imidacloprid) EPA Reg. No. 228-572 Nufarm Americas, Inc **Nuprid 4.6 Pro** EPA Reg. No. 228-527	Caution	12 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either
Off-Shoot T® (C8- C12 fatty alcohols) EPA Reg. No. 400-542 UPL NA Inc.	Danger	24 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks; protective eyewear	coveralls; waterproof gloves; shoes plus socks; protective eyewear	either	either
Orondis Gold 200 (oxathiapiprolin) EPA Reg. No. 100-1571 Syngenta Crop Protection	Caution	4 hrs.	Long-sleeved shirt and long pants; shoes and socks.	Coveralls; shoes and socks.	either	either
Orondis Gold Premix (oxathiapiprolin) EPA Reg. No. 100-1614 Syngenta Crop Protection	Danger	48 hrs.	Protective eyewear, coveralls; shoes and socks, chemical-resistant gloves.	Protective eyewear, coveralls; shoes and socks, chemical-resistant gloves.	either	either
Orondis Ultra A (oxathiapiprolin) EPA Reg. No. 100-1572 Syngenta Crop Protection	Caution	4 hrs.	Long-sleeved shirt and long pants; chemical-resistant gloves; shoes plus socks.	Coveralls; chemical-resistant gloves; shoes and socks.	either	either
Orondis Gold B (mefenoxam) EPA Reg. No. 100-1202 Syngenta Crop Protection	Caution	0 hrs.	Long-sleeved shirt and long pants; chemical-resistant gloves; shoes plus socks.	Coveralls; chemical-resistant gloves; shoes and socks.	either	either
Orondis Ultra B (mandipropamid) EPA Reg. No. 100-1254 Syngenta Crop Protection	Caution	4 hrs.	Long-sleeved shirt and long pants; shoes and socks.	Coveralls; chemical-resistant gloves; shoes and socks.	either	either

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE) [2] Applicators and Other Handlers	Personal Protective Equipment (PPE) [2] To Enter Treated Area Within REI [3]	Worker Notification[4] Oral	Worker Notification[4] Posted
Orthene® 75S (acephate) EPA Reg. No. 59639-26 **Orthene ® 97** EPA Reg. No. 5481-8978 AMVAC Chemical Corp	Caution	24 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks; chemical resistant headgear for overhead exposure	coveralls; waterproof gloves; shoes plus socks; chemical resistant headgear for overhead exposure	either	either
Pasada ® 1.6 F (imidacloprid) EPA Reg. No. 66222-228 ADAMA	Caution	12 hrs.	long-sleeved shirt and long pants, waterproof gloves; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either
Pic Plus (chloropicrin) EPA Reg. No. 8853-6 Triest Ag Group Inc..	Danger	48 hrs. and gas conc. less than 0.1 ppm	coveralls or loose-fitting or well ventilated long-sleeved shirt and long pants; shoes and socks; full-face shield or safety glasses with brow and temple shields (**Do Not** wear goggles); full-face respirator when air concentration exceeds 0.1 ppm	non-handlers prohibited	yes	yes
Platinum ® 2SC (thiamethoxam) EPA Reg. No. 100-939 **Platinum ® 75SG** EPA Reg. No. 100-1291 Syngenta Crop Protection	Caution	12 hrs.	long-sleeved shirt, waterproof gloves, shoes plus socks	coveralls, shirt, waterproof, gloves, shoes plus socks	yes	yes

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE) [2] Applicators and Other Handlers	 To Enter Treated Area Within REI [3]	Worker Notification[4] Oral	 Posted
Plucker-Plus C8 and C10 fatty alcohols Flumetralin EPA Reg. no. 19713-649 Drexel Chemical	Caution	24 hrs.	long-sleeved shirt and long pants, socks; shoes, and chemical-resistant gloves made of any waterproof material such as barrier laminate or viton, , chemical-resistant chemical-resistant headgear for overhead exposure, chemical resistant apron for cleaning equipment, mixing or loading	coveralls over short-sleeved shirt and short pants, protective eyewear, chemical-resistant gloves made of any waterproof material, socks, chemical-resistant footwear,	either	either
Poast® (sethoxydim) EPA Reg. No. 7969-58 BASF Ag Products	Warning	12 hrs.	coveralls over short-sleeved shirt and short pants; chemical resistant gloves ≥14 mils; chemical resistant footwear plus socks; protective eyewear; chemical resistant headgear for overhead exposure; chemical-resistant apron when cleaning equipment, mixing and loading	coveralls over short-sleeved shirt and short pants; chemical resistant gloves ≥14 mils; chemical resistant footwear plus socks; protective eyewear; chemical resistant headgear for overhead exposure	either	either

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2] Applicators and Other Handlers	Personal Protective Equipment (PPE)[2] To Enter Treated Area Within REI[3]	Worker Notification[4] Oral	Worker Notification[4] Posted
Presidio (fluopicolide) EPA Reg. No. 59639-140 Valent U.S.A. Corporation	Caution	12 hr	Long-sleeved shirt and long pants; chemical-resistant gloves; shoes plus socks.	Coveralls; chemical-resistant gloves made of any waterproof material; socks and shoes.	either	either
Prime+® (flumetralin) EPA Reg. No. 100-640 Syngenta Crop Protection	Danger	24 hrs.	coveralls over short-sleeved shirt and short pants; chemical-resistant gloves such as Barrier Laminate or Viton; chemical-resistant foot-wear plus socks; protective eyewear; chemical resistant headgear for overhead exposure; chemical-resistant apron when cleaning equipment, mixing or loading	coveralls over short-sleeved shirt; short pants; chemical-resistant gloves such as Barrier Laminate or Viton; chemical-resistant footwear plus socks; protective eyewear; chemical-resistant headgear for overhead exposure	either	either
Prowl® 3.3 (pendimethalin) EPA Reg. No. 241-337 **Prowl® H2O** (pendimethalin) EPA Reg. No. 241-418 BASF Ag Products.	Caution	24 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves such as Barrier Laminate or Viton >14 mils; shoes plus socks	coveralls; chemical-resistant gloves such as Barrier Laminate or Viton >14 mils; shoes plus socks	either	either

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2] Applicators and Other Handlers	Personal Protective Equipment (PPE)[2] To Enter Treated Area Within REI[3]	Worker Notification[4] Oral	Worker Notification[4] Posted
Quadris (azoxystrobin) EPA Reg. No. 100-1098 Syngenta Crop Protection	Caution	4 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves; shoes plus socks	coveralls; chemical-resistant gloves; shoes plus socks	either	either
Revus (mandipropamid) EPA Reg. No. 100-1254 Syngenta Crop Protection	Caution	4 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves; shoes plus socks	coveralls; chemical-resistant gloves; shoes plus socks	either	either
Ridomil Gold SL ® (mefenoxam) EPA Reg. No. 100-1202 Syngenta Crop Protection	Caution	48 hrs.	long-sleeved shirt and long pants, chemical-resistant gloves, shoes plus socks	coveralls, chemical-resistant gloves, shoes plus socks	either	either
Royaltac (C10 fatty alcohol) EPA Reg. No. 400-135 UPL NA Inc.	Danger	24 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks; protective eyewear	coveralls; waterproof gloves; shoes plus socks; protective eyewear	either	either
Royaltac-M (C8- C12 fatty alcohols) EPA Reg. No. 400-451 UPL NA Inc.	Danger	24 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks; protective eyewear	coveralls; waterproof gloves; shoes plus socks; protective eyewear	either	either
Royal MH-30® (maleic hydrazide) EPA Reg. No. 400-84 UPL NA Inc.	Caution	12 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either
Royal MH Xtra (maleic hydrazide) **EPA Reg. No. 400-452** UPL NA Inc**.**	Caution	12 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2] Applicators and Other Handlers	Personal Protective Equipment (PPE)[2] To Enter Treated Area Within REI[3]	Worker Notification[4] Oral	Worker Notification[4] Posted
Satori Fungicide (azoxystrobin) EPA Reg. No. 34704-1068 Loveland Products	Caution	4 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves; shoes plus socks	coveralls; chemical-resistant gloves; shoes plus socks	either	either
Sniper 2F (bifenthrin) EPA Reg. No. 34704-858 Loveland Products, Inc.	Warning	12 hrs.	long-sleeved shirt and long pants, chemical-resistance gloves, such as Barrier Laminate or Nitrile rubber or Vitron and shoes plus socks and protective eyewear	coveralls, chemical-resistant gloves, such as Barrier Laminate or Nitrile rubber or Neoprene rubber or Vitron, and shoes plus socks	either	either
Spartan ® 4F (sulfentrazone) EPA Reg. No. 279-3220 FMC Corporation	Caution	12 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks	coveralls over long-sleeved shirt and long pants; water-proof gloves; shoes plus socks	either	either
Spartan Charge (sulfentrazone + carfentrazone) EPA Reg No. 279-3337 FMC Corporation	Caution	12 hrs.	long-sleeved shirt and long pants; chemical resistant gloves made of waterproof material such as polyethylene or polyvinyl chloride; shoes plus socks	coveralls over long-sleeved shirt and long pants; chemical resistant gloves; shoes plus socks	either	either
Steward EC (Indoxacarb) EPX Reg No. 279-9596 FMC Corporation	Caution	12 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks	coveralls over long-sleeved shirt and long pants; water-proof gloves; shoes plus socks	either	either

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2] Applicators and Other Handlers	Personal Protective Equipment (PPE)[2] To Enter Treated Area Within REI[3]	Worker Notification[4] Oral	Worker Notification[4] Posted
Sucker Plucker® (C8- C10 fatty alcohols) EPA Reg. No. 19713-35 Drexel Chemical	Danger	24 hrs.	coveralls over short-sleeved shirt and short pants; waterproof gloves; protective eyewear; chemical resistant footwear plus socks; chemical resistant headgear for overhead exposure; chemical resistant apron when cleaning equipment, mixing or loading	coveralls over short-sleeved shirt and short pants; waterproof gloves; protective eyewear; chemical resistant footwear plus socks; chemical resistant headgear for overhead exposure	either	either
Sucker Stuff® (maleic hydrazide) EPA Reg. No. 19713-1 **Super Sucker Stuff®** EPA Reg. No. 19713-20 Drexel Chemical	Caution	12 hrs.	long-sleeved shirt and long pants; shoes plus socks; waterproof gloves	coveralls; waterproof gloves; shoes plus socks	either	either

Product Trade Name (common name) EPA Reg. No. Company Name	**Signal Word**	**Restricted Entry Interval (REI)[1]**	**Personal Protective Equipment (PPE) [2] Applicators and Other Handlers**	**To Enter Treated Area Within REI [3]**	**Worker Notification[4] Oral**	**Posted**
Telone® II (1,3-Dichloropropene) EPA Reg. No. 95290-1 Teleos Ag Solutions	Warning	5 days	**see label for extensively detailed instructions for PPE**	Non-handlers prohibited; **see label for extensive instructions for handlers**	yes	yes
Terramaster 4EC (etridiazole) EPA Reg. No. 400-422 UPL NA Inc.	Danger	12 hrs.	long-sleeved shirt and long-pants, chemical resistant gloves such as barrier laminate or viton, shoes plus socks, NIOSH approved respirator, chemical-resistant apron when mixing, etc.	coveralls, chemical-resistant gloves such as barrier laminate or viton, shoes plus socks, protective eyewear	yes	yes
TMOXX ® 2SC (thiamethoxam) EPA REg. No. 100-939-51873 Fair Products	Caution	12 hrs.	long-sleeved shirt, waterproof gloves, shoes plus socks	coveralls, shirt, waterproof, gloves, shoes plus socks	yes	yes
Tri-Pic 100® (chloropicrin) EPA Reg. No. 8536-2-87994 Triest Ag Group**.**	Danger	48 hrs. and gas concen-tration less than 0.1 ppm	loose fitting or well ventilated long-sleeved shirt and long pants; shoes and socks; fullface shield or safety glasses with brow and temple shields. (Do NOT) wear goggles, full-face respirator when air concentration exceeds 0.1 ppm.	non-handlers prohibited	yes	yes

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2] Applicators and Other Handlers	Personal Protective Equipment (PPE)[2] To Enter Treated Area Within REI[3]	Worker Notification[4] Oral	Worker Notification[4] Posted
Ultra Flourish (mefenoxam) EPA Reg. No. 55146-73 NuFarm Agricultural Products	Warning	48 hrs.	long-sleeved shirt and long pants, chemical-resistant gloves, shoes plus socks, protective eyewear	coveralls, chemical-resistant gloves, shoe plus socks, protective eyewear	yes	yes
Vapam HL® (metam sodium) EPA Reg. No. 5481-468 Amvac Chemical Corporation **Metam CLR®** EPA Reg. No. 45728-16 Taminco, Inc. **Sectagon 42®** EPA Reg. No. 61842-6 Tessenderlo Kerley, Inc.	Danger	48 hrs.	coveralls over long-sleeved shirt and long pants; chemical-resistant gloves made of any waterproof material; chemical resistant footwear plus socks; chemical resistant headgear for overhead exposure; chemical resistant apron when cleaning equipment or when mixing, loading or transferring without dry-disconnect fittings; face-sealing goggles, unless full-face respirator is worn; respirator with organic-vapor-removing cartridge with a prefilter or canister approved for pesticides, or a NIOSH approved respirator with an organic (OV) cartridge or canister with any N, R, P, or HE prefilter.	coveralls over long-sleeved shirt and long pants; chemical-resistant gloves made of any waterproof material; chemical-resistant footwear plus socks	yes	yes
Velum Prime (fluopyram) EPA Reg. No. 264-1078 Bayer CropScience	Caution	12 hrs.	long-sleeved shirt and long pants; shoes plus socks	Coveralls over long-sleeved shirt and long pants, shoes plus socks, and chemical resistant gloves	either	either
Verimark (cyantraniliprole) EPA Reg. No. 279-9616 FMC	None	4 hrs.	long-sleeved shirt and long pants; shoes plus socks	Coveralls, shoes plus socks, and chemical resistant gloves	either	either

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2] Applicators and Other Handlers	Personal Protective Equipment (PPE)[2] To Enter Treated Area Within REI[3]	Worker Notification[4] Oral	Worker Notification[4] Posted
Vydate C-LV (oxamyl) EPA Reg. No. 352-532 DuPont.	Danger	48 hr	Coveralls; chemical-resistant gloves such as barrier laminate or butyl rubber; chemical resistant footwear plus socks; protective eyewear; chemical-resistant headgear for overhead exposure; chemical-resistant apron when cleaning equipment, mixing, or loading; respirator with organic vapor-removing cartridge with prefilter approved for pesticides (prefix TC-23C) or canister approved for pesticides (prefix TC-14G) or NIOSH-approved respirator with organic vapor (OV) cartridge or canister with any R, P, or HE prefilter.	Coveralls; chemical-resistant gloves made of any waterproof material; socks and shoes.	either	either
Vydate L (oxamyl) EPA Reg. No. 352-372 DuPont.	Danger	48 hr	Coveralls over long-sleeved shirt and long pants; chemical-resistant gloves such as barrier laminate or butyl rubber or neoprene rubber or polyvinyl chloride (PVC) or viton or nitrile rubber; chemical resistant footwear plus socks; protective eyewear; chemical-resistant headgear for overhead exposure; chemical-resistant apron when cleaning equipment, mixing, or loading; respirator with organic vapor-removing cartridge with prefilter approved for pesticides (prefix TC-23C) or canister approved for pesticides (prefix TC-14G) or NIOSH-approved respirator with organic vapor (OV) cartridge or canister with any R, P, or HE prefilter.	Coveralls; chemical-resistant gloves made of any waterproof material; socks and shoes.	either	either

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2] Applicators and Other Handlers	To Enter Treated Area Within REI[3]	Worker Notification[4] Oral	Posted
Warrior II (lambda-cyhalothrin) EPA Reg. No. 100-1295 Syngenta	Warning	24 hrs.	long-sleeved shirt and long pants, chemical resistant gloves, shoes plus socks, protective eyewear	coveralls, chemical resistant gloves, shoes, plus socks	either	either
XenTari® (*Bacillus thuringiensis)* EPA Reg. No. 73049-40 Valent	Caution	4 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks; dust/mist filtering respirator (MSHA/NIOSH approved number prefix TC-21C)	coveralls; waterproof gloves; shoes plus socks	either	either

[1] Exception: If the product is soil-injected or soil-incorporated, the Worker Protection Standard, under certain circumstances, allows workers to enter the treated area if there will be no contact with anything that has been treated.

[2]Represents the minimum PPE required; more protective clothing can be worn. See product label for recommended chemical-resistant glove materials.

[3] Refer to "Early Entry Work Situations" in *The Worker Protection Standard for Agricultural Pesticides—How to Comply,* pages 59-61, "Short-Term Tasks," "Emergency Tasks," and "Specific Tasks Approved by EPA Through a Formal Exception Process." See pages 45-47 for information on "Restrictions During and After Applications" including exceptions: 1) "Early Entry With No Contact" and 2) "Early Entry With Contact for Short-Term, Emergency," or "Specially Excepted Tasks."

[4] **Notification on Farms, Forests, and Nurseries:** Refer to page 41, *The Worker Protection Standard for Agricultural Pesticides—How to Comply.* Unless the pesticide labeling requires both types of notification, notify workers either orally or by posting of warning signs at entrances to treated areas. You must inform workers which method of notification is being used.

Both Oral Warning and Posted Signs: Some pesticide labels require you to notify workers both orally and with signs posted at entrances to the treated area. If both types of notification are required, the following statement will be in the "Directions for Use" section of the pesticide labeling under the heading Agricultural Use Requirements: "Notify workers of the application by warning them orally and by posting warning signs at entrances to treated areas."

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Annual Report

July 1, 2021 – June 30, 2022

MISSION

To plan and conduct campaigns of sales promotion, advertising, publicity, research, and education for the purpose of increasing the demand for and consumption of Virginia flue-cured tobacco.

COMPOSITION OF THE BOARD

The Virginia Tobacco Board is composed of nine tobacco producers who are appointed by the Governor. The Governor is guided in his appointments by recommendations of organizations that represent flue-cured tobacco producers. The members represent legislatively defined flue-cured tobacco producing areas in Virginia.

FUNDING

Program funding is derived from an excise tax that is paid by all flue-cured tobacco producers. The excise tax levy is 40 cents per hundred pounds of tobacco sold. This tax is collected by company receiving stations at the time tobacco is sold by producers, remitting payment to the board, which is responsible for ensuring that the tax has been properly collected and remitted.

BOARD PROGRAMS

I. Market Development and Promotion

The Virginia Tobacco Board, by contractual agreement, provided Tobacco Associates, Inc. with $52,800 to be used in various market development and promotional projects. Tobacco Associates, Inc. is the U.S. Tobacco producers' promotional organization whose main objective is to promote U.S. flue-cured tobacco throughout the world. Tobacco Associates, Inc. is funded through producer assessments in all flue-cured tobacco producing states; in Virginia's case, by virtue of the appropriation of the Board. Tobacco Associates, Inc. is governed by a producer-controlled board of directors with two members being from Virginia.

II. Research

The Virginia Tobacco Board funded six research projects on flue-cured tobacco, which were conducted by the Virginia Tech Southern Piedmont Agricultural Research and Extension Center. Funds available from the Board enabled researchers and Virginia Cooperative Extension specialists to conduct timely tobacco production research in agronomy, entomology, and pathology.

III. Education

The Virginia Tobacco Board provided funding for the annual Flue-Cured Tobacco Production Guide, which was prepared and distributed by Virginia Cooperative Extension. This publication provides current information to producers on all aspects of flue-cured tobacco production. The Board also made a donation to Virginia Agriculture in the Classroom.

BRIGHT FLUE-CURED TOBACCO PROMOTION FUND FINANCIAL STATEMENT

July 1, 2021 – June 30, 2022

Cash balance (June 30, 2021)		=	$139,181.18
Excise Tax Receipts (July 1, 2021 – June 30, 2022)		+	$129,986.84
Interest and Other Income Earned		+	$4,173.48
Actual Expenditures		-	$136,478.15
- Marketing/Promotion	$52,800.00		
- Research	$81,341.19		
- Education	$1,900.00		
- Administrative	$436.96		
Cash Balance (June 30, 2022)		=	$136,863.35

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This information is being provided in accordance with legislation passed in the 2012 Virginia General Assembly, which requires each commodity board to provide an annual report to its producers that pay an excise tax.