Tobacco

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2012 FLUE-CURED TOBACCO PRODUCTION GUIDE

Virginia Cooperative Extension

VirginiaTech Invent the Future

Virginia State

in cooperation with the

Virginia Bright Flue-Cured Tobacco Board

2012 FLUE-CURED TOBACCO

PRODUCTION GUIDE

Prepared By:

T. David Reed	**Extension Agronomist, Tobacco**
Charles S. Johnson	**Extension Plant Pathologist, Tobacco**
Paul J. Semtner	**Extension Entomologist, Tobacco**
Carol A. Wilkinson	**Associate Professor, Agronomy**

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FLUE-CURED TOBACCO BUDGET INFORMATION

Eric Eberly, Retired Extension Agent, Farm Business Management

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 2012. The price of fuels used in the budget reflects this estimation which is below the highs in 2008 but above current farm delivered prices.

3. Since the AWER wage calculation method is being litigated, the AWER wage for 2012 is uncertain. Labor cost is estimated to be $12.62 per hour. It includes an unpublished adverse wage of $9.70 and indirect labor cost of $2.89 per hour. The indirect labor cost per hour is calculated by dividing total direct labor costs of $15,724 (association fees, visas, transportation, housing, insurance, et.) by 5000 hours of labor (50 acres x 100 hours).

4. Crop insurance cost of $133.46 per acre was calculated by dividing the total unsubsidized premiums payable by total Virginia acreage insured in 2011.

Budget Interpretation

Income and expense items for the 2012 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
2500 POUND YIELD

Acres
1

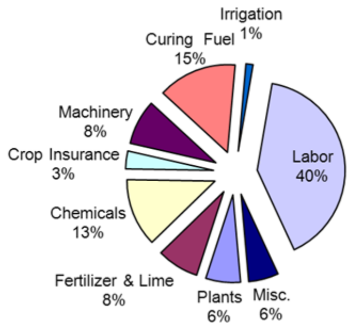
		Unit	Quantity /Acre	Price or Cost/ Unit	Total Acre	Your Farm
1. GROSS RECEIPTS						
Stalk Position Lbs						
Stalk Position Lbs						
Stalk Position Lbs						
Stalk Position Lbs						
TOTAL RECEIPTS:		Lbs			**$0.00**	
2. PRE-HARVEST VARIABLE COSTS						
TOBACCO PLANTS - Flue-cured		1M	6.20	$35.00	$217.00	
Cover Crop: Rye		BU.	2.00	$12.20	$24.40	
Lime (Prorated)		TON	0.56	$42.50	$23.80	
FRow: Fertilizer (6-12-18)		CWT	6.50	$35.50	$230.75	
Sidedress: (13-0-14)		CWT	2.50	$36.00	$90.00	
Herbicides		ACRE	1.00	$32.09	$32.09	
Insecticides		ACRE	1.00	$42.35	$42.35	
Fungicides		ACRE	1.00	$80.00	$80.00	
Nematicides		ACRE	1.00	$211.75	$211.75	
Sucker Control		ACRE	1.00	$73.00	$73.00	
Federal Crop & Hail Insurance APH		ACRE	1.00	$133.46	$133.46	
Land Rent		ACRE	1.00	$0.00	$0.00	
Tractor Equip: Fuel & Oil		Eq Gal	53.32	$3.53	$188.21	
Tractor & Equip.: Repairs		ACRE	1.00	$68.76	$68.76	
Tractor & Equip.: Labor		HRS	15.89	$14.50	$230.41	
Hand Production Labor		HRS	35.00	$12.62	$441.70	
Production Interest	6	Months	$1,043.84	6.0%	$62.63	
TOTAL PRE-HARVEST COSTS			**$0.86 Per Pound**		**$2.150.31**	
3. HARVEST VARIABLE COSTS						
Tractor Equip: Fuel & Oil		Eq Gal	18.67	$3.53	$65.92	
Tractor & Equip.: Repairs		ACRE	1.00	$31.32	$31.32	
Tractor & Equip.: Labor		HRS	9.98	$14.50	$144.71	
Hand Harvest Labor		HRS	60.00	$12.62	$757.20	
Curing Fuel (LP)	8	gal/cwt	312.50	$1.88	$587.50	
Building Ins. & Electricity		ACRE	1.00	$108.68	$108.68	
Supplies		ACRE	1.00	$10.07	$10.07	
TOTAL HARVEST COSTS:			**$0.68 Per Pound**		**$1,705.40**	
		Breakeven Yield		**Breakeven Price**		
4. TOTAL VARIABLE COSTS		**# Pounds**		**$1.54 Per Pound**	**$3,855.71**	
5. RETURN OVER TOTAL VARIABLE COST					**$0.00**	
6. MACHINERY FIXED COSTS (BASED ON NEW EQUIPMENT COST)						
		ACRE	1.00	$767.07	$767.07	
7. OTHER FIXED COSTS		DOL	$3,855.71	**8.0%**	**$308.46**	
8. TOTAL FIXED COSTS				$0.43 Per Pound	$1,075.53	
9. TOTAL VARIABLE & FIXED COSTS			**$1.97 Per Pound**		**$4,931.24**	
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 2012 crop are estimated at $3,855.71 per acre or $1.54 a pound. The breakdown of variable costs is displayed in Figure 1. Fixed Costs were estimated at $$1,075.53 an acre or $0.43 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	$4,813.74	0.54	$2.41	$2.53	$2.66	$2.78	$2.91
2250	$4,872.49	0.48	$2.17	$2.28	$2.39	$2.50	$2.61
2500	$4,931.24	0.43	$1.97	$2.07	$2.17	$2.27	$2.37
2750	$4,989.99	0.39	$1.81	$1.91	$2.00	$2.09	$2.18
3000	$5,048.74	0.36	$1.68	$1.77	$1.85	$1.93	$2.02

1. Fixed Cost does not include a land charge. Subtract $.53, $.47, $.43, $.39, $.36 per Lb respectively in the table above to remove Fixed Costs at each yield level.

10% Yield Sensitivity

This budget was developed in Microsoft Excel and is available from your county Extension Office or online at: http://www.vaes.org.vt.edu/SPAREC/Ftobacco.xls.

AGRONOMIC INFORMATION

T. David Reed, Extension Agronomist, Tobacco

VARIETY SELECTION

Variety selection is an important decision for profitable production of flue-cured tobacco. A high potential yield is probably more important than ever before due to reduced operating margins. However, ease of curing and specific characteristics of the cured leaf should also be considered. Varieties will differ in cured leaf color and other physical characteristics desired by purchasers (color proportion of tip leaves, etc.), but these factors are also influenced by growing conditions and curing practices. Growers should carefully consider any dramatic change in varieties grown without first trying a different variety on a limited acreage. The disease resistance of varieties varies greatly and is critical to profitable production. Detailed field histories should be maintained with specific information on past varieties planted and the level of disease occurrence.

Tobacco breeders have made tremendous progress in recent years developing resistance to the major diseases of 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. To further complicate matters, there have been isolated cases of less common root diseases that are not typically evaluated for in typical variety tests. If past performance of a disease resistant variety has been less than anticipated, growers are encouraged to contact your 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.

There are no data collected for tobacco seed sales in Virginia or official reporting of acreage planted by variety. The best information that we have is informal surveys conducted at grower meetings and consultation with dealers. Perhaps as many as 12 flue-cured tobacco different varieties were grown on any appreciable acreage in Virginia last season. The three most widely grown varieties in Virginia for 2011 were K 326, NC 71, and NC 196 with 20 and 30% of the acreage each. CC 27 remains a popular choice while NC 291, NC 299, CC35, NC 297, PVH2110 have a significant presence. For growers that have fields with no history of black shank, Granville wilt, or tobacco cyst nematodes, K 326 remains a popular choice given the variety's high yield potential, high quality, and ease of curing. NC 71 was one of the first Ph-gene varieties, becoming an industry standard with near immunity to race 0 black shank. CC 27 is a later release with the Ph gene plus the addition of tobacco mosaic virus (TMV) resistance with good curing characteristics. An added benefit of the Ph gene varieties is tolerance to the tobacco cyst nematode. The widespread planting of varieties with the Ph gene has significantly reduced TCN populations in rotated tobacco fields. However, continued planting of these varieties has resulted in black shank control problems due to the development of a race 1 black shank fungus. More recently, NC 196 has gained popularity given the fact that it has Ph gene resistance to race 0 black shank, increased resistance to race 1, and a high yield potential. Additional information regarding black shank control and resistance ratings for both race 0 and race 1 may be found in the disease management chapter of this guide.

The results from the 2011 Flue-Cured Tobacco Official Variety Trial conducted at the Southern Piedmont Center 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 (NC 102, CC 67, CC37, and RG 17). Values of 104 or 96 indicate that the yield of a particular variety was 4 percent above or below the test average, respectively.

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.

Three new varieties will be commercially available for the 2012 seasonsee page 11. These varieties have passed the Minimum Standards Program conducted by the regional Flue-Cured Tobacco Variety Evaluation Committee. This program is conducted to ensure that all new varieties meet certain chemical characteristics, usability standards, and have smoke flavor characteristics that are acceptable to the industry. Approval by this committee does not necessarily mean that the variety possesses any agronomic or disease resistance characteristics superior to our currently available commercial varieties.

Table 1. Agronomic results from the 2011 Official Variety Trial conducted at Southern Piedmont Center - Blackstone, VA. New varieties are in bold.

Variety	Yield (lbs/ac)	Relative Yield	Grade Index
NC 27 NF	4540	113	82.0
NC 71	4503	112	82.3
CC 13	4496	112	70.3
PVH 2110	4392	110	78.3
CC 35	4376	109	77.0
PVH 1596	4376	109	74.0
CC 27	4307	107	75.0
NC 299	4302	107	76.0
K 326	4247	106	75.0
NC 291	4241	106	66.3
NC 72	4236	106	70.3
NC 297	4235	106	76.0
CC 65	**4213**	**105**	**74.7**
NC 196	4180	104	82.3
PVH 2248	4179	104	82.3
NC 55	4175	104	77.7
CC 33	4108	103	81.7
PVH 1452	4108	103	72.7
CC 700	4103	102	77.0
GF 318	**4088**	**102**	**78.0**
NC 606	4085	102	81.0
Sp. 220	4070	102	82.7
NC 102	4024	100	75.0
CC 67	4022	100	79.7
CC 37	4009	100	82.0
RG 17	4005	100	75.3
NC 37 NF	3976	099	80.0
VA 119	3965	99	79.0
RGH 51	3914	98	70.3
NC 92	**3866**	**96**	**75.0**
K 394	3849	96	81.7
Sp. 168	3839	96	81.3
NC 471	3707	93	77.7
K 149	3686	92	70.3
Sp. 225	3666	91	77.7
Sp. 236	3627	91	75.0
PVH 1118	3597	90	81.7
K 346	3594	90	76.0
GL 939	3455	86	82.3
K 399	3435	86	85.0
Sp. 227	3387	85	79.0
Test Average	4029		77.5

Table 2. Relative yields for Flue-Cured Tobacco Official Variety Trials conducted at the Southern Piedmont Center near Blackstone, Virginia for 2009-2011.

	Relative Yield and Ranking within Year			3-yr Avg. Relative
Variety	2011	2010	2009	Yield
NC 27 NF	113 *(1)*	109 *(4)*	107 *(12)*	110
NC 71	112 *(2)*	107 *(9)*	108 *(8)*	109
CC 13	112 *(2)*	109 *(4)*	97 *(32)*	106
PVH 2110	110 *(4)*	109 *(4)*	106 *(14)*	108
CC 35	109 *(5)*	118 *(1)*	110 *(6)*	113
PVH 1596	109 *(5)*	92 *(40)*	96 *(34)*	99
CC 27	107 *(7)*	99 *(22)*	112 *(2)*	106
NC 299	107 *(7)*	100 *(20)*	102 *(21)*	103
K 326	106 *(9)*	109 *(4)*	108 *(10)*	108
NC 291	106 *(9)*	101 *(17)*	108 *(10)*	105
NC 72	106 *(9)*	104 *(11)*	105 *(14)*	105
NC 297	106 *(9)*	100 *(20)*	107 *(12)*	104
CC 65	105 *(13)*	112 *(2)*	113 *(1)*	110
NC 196	104 *(14)*	105 *(10)*	112 *(2)*	107
NC 55	104 *(14)*	99 *(22)*	98 *(30)*	101
CC 33	103 *(17)*	101 *(17)*	104 *(16)*	103
PVH 1452	103 *(17)*	95 *(34)*	104 *(18)*	100
CC 700	102 *(19)*	104 *(11)*	109 *(6)*	105
GF 318	102 *(19)*	110 *(3)*	109 *(8)*	107
NC 606	102 *(19)*	101 *(17)*	98 *(30)*	100
Sp. 220	102 *(19)*	95 *(34)*	92 *(39)*	96
NC 102	100 *(23)*	103 *(14)*	103 *(20)*	102
CC 67	100 *(23)*	96 *(33)*	104 *(18)*	100
CC 37	100 *(23)*	98 *(27)*	112 *(2)*	103
RG 17	100 *(23)*	99 *(22)*	100 *(26)*	100
NC 37 NF	99 *(27)*	102 *(15)*	95 *(36)*	99
VA 119	99 *(27)*	97 *(30)*	97 *(32)*	98
RGH 51	98 *(29)*	104 *(11)*	95 *(36)*	99

--- Continued ---

Table 2. Relative yields for Flue-Cured Tobacco Official Variety Trials conducted at the Southern Piedmont Center near Blackstone, Virginia for 2009-2011.

	Relative Yield and Ranking within Year			3-yr Avg. Relative
Variety	2011	2010	2009	Yield
NC 92	96 *(30)*	97 *(30)*	104 *(16)*	99
K 394	96 *(30)*	99 *(22)*	112 *(2)*	102
Sp. 168	96 *(30)*	89 *(43)*	99 *(29)*	95
NC 471	93 *(33)*	92 *(40)*	93 *(38)*	93
K 149	92 *(34)*	97 *(30)*	100 *(26)*	96
Sp. 225	91 *(35)*	90 *(42)*	79 *(47)*	87
Sp. 236	91 *(35)*	87 *(46)*	81 *(46)*	86
PVH 1118	90 *(37)*	108 *(8)*	101 *(23)*	99
K 346	90 *(37)*	94 *(36)*	92 *(39)*	92
GL 939	86 *(39)*	98 *(27)*	100 *(26)*	94
K 399	86 *(39)*	98 *(27)*	96 *(34)*	93
Sp. 227	85 *(41)*	88 *(45)*	102 *(21)*	91

CC 65 is an F1 hybrid developed by R.J. Reynolds Tobacco Company. Seed will be produced and marketed by Cross Creek Seed Company. The variety is a sister line to CC 35 with comparable black shank resistance to race 0 and 1 and slightly less resistance to Granville wilt. CC 65 is resistant to the common root knot nematode and is susceptible to tobacco mosaic virus (TMV).

GF 318 is an F1 hybrid developed by Gwynn Farms with seed production by Raynor Seed Farms. The variety will be marketed by Gold Leaf Seed Company. GF 318 is resistant to tobacco mosaic virus and thus is comparable to N C297 with slightly better resistance to race 1 black shank (does have Ph gene). Resistance to Granville wilt is considered as moderate and the variety is resistant to the common root knot nematode.

NC 92 is an F1 hybrid developed by the tobacco breeding program at North Carolina State University with the seed available through F.W. Rickard Seed Company. The variety has the Ph gene resistance to race 0 black shank and moderate resistance to race 1 as well as Granville wilt. NC 92 is resistant to the common root knot nematode and is susceptible to tobacco mosaic virus.

GREENHOUSE TRANSPLANT PRODUCTION

Greenhouse tobacco transplant production remains the standard for the industry and growers have become quite accustom to growing transplants. Only a very small amount of any tobacco type in Virginia is still grown with transplants from traditional plant beds. Relatively few tobacco transplants are imported into Virginia. Transplants are generally produced on the farms where they are to be transplanted or purchased from greenhouse transplant growers in Virginia. Actual production problems have been relatively minor and not widespread in recent years. The most 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 incidence of spiral root seedlings has declined in recent years as seed coating materials 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 3. 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 3. 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). Growers need to be mindful of the condition of greenhouse media when purchasing and avoid product that is either too wet or dry. 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

A research trial was conducted at the Southern Piedmont Center in 2010 to evaluate the timing of initial fertilization on seedling performance and usable transplants. Two commercial tobacco greenhouse media were compared: Carolina Choice and Sunshine LT-5. Fertilizer (100 ppm N) was added to bays at seeding, 1 day after seedling (1 DAS), 5 DAS, and 14 DAS. There was little difference observed between the two brands of media (Table 4). The timing of initial fertilization did not have an effect on 14-day plant stand or the number of spiral root seedlings. Fertilizer timing did impact other factors. Delaying fertilization to 5 DAS decreased seedling mortality and increased the percentage of usable transplants. This response was greater with Carolina Choice mix.

Table 4. Results of greenhouse fertilization timing study conducted at the Southern Piedmont Center, 2010. Data shown are averages of six replications.

Timing of initial fertilization	14-dy stand	Usable transplants	Spiral roots	Small seedlings	Seedling mortality
Carolina Choice		------------------- (%)	-------------------		
At seeding	94	82 b	0.8	3.3 b	9.3 a
1 DAS	95	84 b	1.0	6.8 a	5.3 ab
5 DAS	97	91 a	1.3	3.5 ab	2.3 b
14 DAS	97	92 a	1.5	3.8 ab	1.8 b
Sunshine LT-5					
At seeding	95	86 b	3.5 a	6.5	3.3
1 DAS	96	89 ab	1.0 ab	5.3	2.5
5 DAS	96	90 a	0.5 b	4.0	1.8
14 DAS	95	92 a	3.0 a	2.8	1.0

Data values in the table are significantly different for a brand of media when followed by a different letter.

Media samples (see Figure 1) were repeatedly collected from the trays over the period of time when seedlings are susceptible to that fertilizer salts injury (usually first 3 weeks after seeding). The measure of the fertilizer salts content in the growing medium is measured as electrical conductivity (Ec) and can be expressed in many different units, including millisiemens (mS) as shown below. The results of this study did not show a substantial difference in Ec between the two brands of media tested and trends over time for the different fertilization treatments were similar. However, the impact of earlier fertilizer addition to the float bays was apparent. Past research has indicated that fertilizer salts injury is most likely to occur between 14 and 21 days after seeding (DAS) where Ec values are above 3.0 mS. Values greater than 3.0 were observed for both media where the fertilizer was added at seeding or 1 DAS. Although seedling mortality was not too severe in this trial, this is consistent with the levels of mortality observed with these treatments. Adding fertilizer 5 and 14 DAS did not result in Ec levels above 3.0 and the observed seedling mortality was not likely to be related to fertilizer salts. Delay of fertilization to 14 DAS resulted in a depression in the Ec values and levels did not reach that on earlier treatments by 23 DAS. Although, this may not always result in slower seedling growth, there is the possibility for lower leaves to turn pale as the seedlings near the time of the first clipping and this can create conditions that favor the development of foliar diseases.

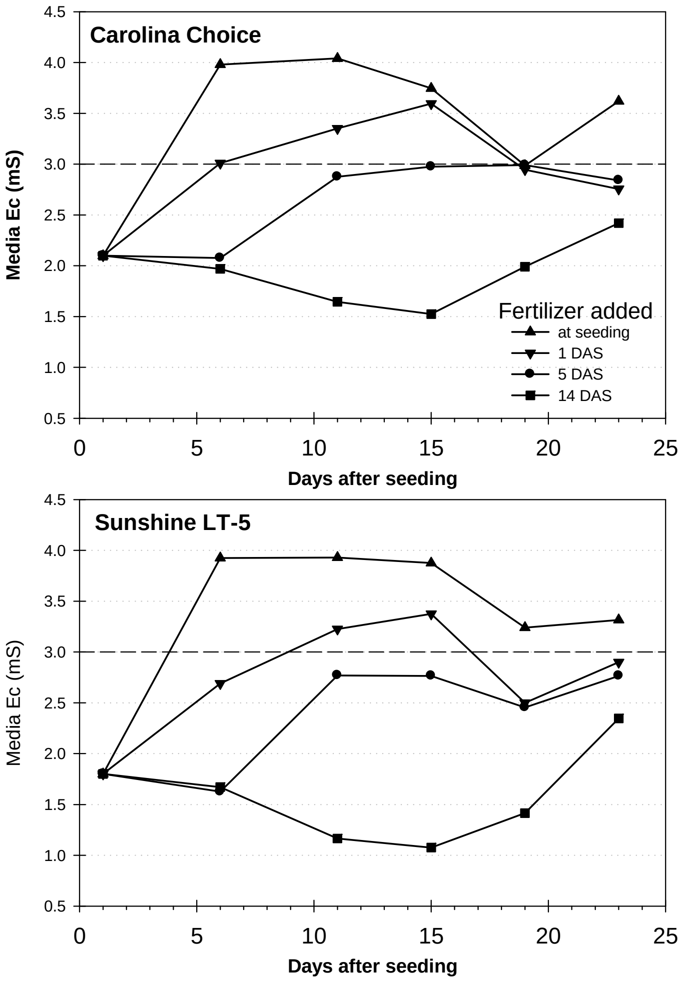


Figure 1. Fertilizer salts (Ec) for four fertilizer timing treatments with two different brands of media. Ec measured of solution extracted directly from media in tray cells. Data for Carolina Choice and Sunshine LT-5 are shown in the upper and lower graphs, respectively. Test conducted at the Southern Piedmont Center, 2010.

Growers are familiar with measuring fertilizer levels in bay water and the testing of levels actually in the media as shown in the research described above is also a valuable management tool. The procedure used in the Virginia tobacco extension program to test media is a direct extraction of water from the media in the trays. Growers interested in using this procedure to monitor their greenhouse fertilizer salts levels may contact their local extension agent or refer to the following web page (http://www.arec.vaes.vt.edu/southern-piedmont/index.html) for details.

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 maximum germination is obtained, the minimum temperature should be maintained at 70 to 72^{o}F. Extended periods of cooler temperatures will delay germination and may decrease the uniformity in the size of the seedlings. After germination, the minimum temperature may be initially reduced to 60-65^{o}F and later to 55^{o}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^{o}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^{o}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.

Recent research conducted by Dr. David Smith at NCSU has investigated how flue-cured tobacco varieties differ in their germination response to temperature. This research focused on NC 71, which has been characterized as being inconsistent in germination when examined across a large number of greenhouses. Results demonstrated that NC 71 is especially sensitive to temperature conditions. Although a fluctuation in day to night temperatures was beneficial, only moderately excessive daytime temperatures can induce seed dormancy, resulting in delayed germination. The best germination was obtained for NC 71 with a temperature regime of 68 and 85^{o}F.

<u>Avoid seeding too early</u> 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^{o}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. <u>Media And Tray Filling</u>

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 <u>125 ppm N</u> 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: $\frac{150\ \text{ppm N}}{16\%\ \text{N}} \times 1.33 = 12.5\ \text{oz per 100 gal}$

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.

A series on-farm greenhouse trials conducted in 2009 followed up on the timing of fertilizer addition as well as the impact of media and seed source on useable transplants. In this study, fertilizer was added at 3 or 14 days after seeding and not significant differences were observed in seedling performance or useable transplants (Table 5). Comparing four brands of media, small differences were observed in both useable transplants and small transplants and not differences were observed between the two sources of seed for K 326 used in this study (Table 6). Only minimal numbers of spiral root seedlings were observed with these tests with flue-cured tobacco. In an accompanying study with burley tobacco in the same greenhouse, an overall level of 7.0% spiral root seedlings were observed. Of these, 34% resulted in useable transplants, 19% were consider too small for transplanting, and 47% died before transplanting.

Table 5. Seedling performance and useable transplants resulting from a test with two times of initial fertilizer addition and four brands of media. Owen Greenhouse, Pittsylvania County, 2009.

	14-day Emergence	21-day stand	Useable transplants	Small transplants
	------------------------ (%)	------------------------		
Fertilizer addition				
3 DAS	91.0	95.5	88.7	6.4
14 DAS	92.4	95.5	89.2	5.9
Brands of media				
Beltwide	89.1	95.9	85.2 b	10.1 a
Carolina Choice	90.4	95.2	88.0 ab	6.2 ab
Southern States Coir	94.5	95.9	90.6 a	4.4 b
Sunshine LT5	92.8	95.0	92.1 a	3.2 b

Table 6. Seedling performance and useable transplants resulting from a test with two seed sources (K 326) and five brands of media. Owen Greenhouse, Pittsylvania County, 2009.

	14-day Emergence	21-day stand	Useable transplants	Small transplants
	------------------------ (%)	------------------------		
Seed source				
Cross Creek	93.8 b	96.1	92.0	3.8
Gold Leaf	96.1 a	95.7	91.3	4.8
Brands of media				
Beltwide	94.1	97.5	88.1	7.4 a
Carolina Choice	96.4	96.7	91.9	4.1 ab
Southern States Coir	93.8	95.0	91.3	4.3 ab
Sunshine LT5	93.4	95.8	93.9	2.0 c
Southern States	96.0	96.1	92.0	3.7 ab

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. However, a 6-3-18 grade is now available and should be considered as a more economical option for soils testing very high (VH) to high (H) for soil P. In addition, research conducted in Virginia has shown 6-3-18 to be suitable for soils testing with medium (M) P level when used in combination with a high P starter fertilizer supplying 4.5 to 5 lbs/ac of P_2O_5.

The most appropriate sidedress fertilizer product is dependent on how much potash is recommended based on the soil test level. If sufficient potash can be supplied with the complete fertilizer, then a N only product supply can be used. The traditional tobacco sidedress sources: nitrate of soda (16-0-0) and soda-potash (15-0-14) are no longer available. If additional potash is required, products such as 14-0-14 (all nitrate-N) and 13-0-14 (majority ammonical-N) are available. A blended 15-0-14 product N predominately as ammonical-N may also be available. Calcium nitrate (15.5-0-0) is the primary N only sidedress product available. The use of liquid nitrogen solutions has been tested and are effective if applied properly. Accurate fertilizer applicator calibration is important and the material should be incorporated into the soil for successful use a tobacco sidedresser. Other products containing various combinations of ammonium nitrate, ammonium sulfate, and/or urea are not suggested for use on flue-cured tobacco.

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.

<u>Nitrogen</u>

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 4 (taken from N. C. Agric. Ext. Serv. Pub. AG-187) may be used as a general guide for making leaching adjustments.

Table 7. 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_20_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_20) 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_20_5) and potassium (K_20).

Soil Test Category	Pounds suggested per acre P_20_5	K_20
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_20_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.

Sidedress Fertilizer Evaluation

Growers have lost two popular tobacco sidedress fertilizers in recent years: 16% nitrate of soda and 15-0-14. Tests were conducted in 2006 to investigate available sidedress products. Data from the test conducted at the Southern Piedmont Center are reported in Table 6.

Table 8. Agronomic results of a sidedress fertilizer comparison conducted at the Southern Piedmont Center in 2006.

Sidedresses	Yield (lbs/A)	Grade Index	Price ($/lb)
13-0-14	3892	87.3	1.47
14-0-14	3736	86.0	1.46
15-0-14	3614	85.0	1.43
15.5-0-0	3408	86.7	1.45
CN-9	3213	88.0	1.47
UAN-30	3872	85.3	1.44
CN-9 plus K-Mag	3459	87.0	1.47
UAN plus K-Mag	3552	88.0	1.48

Complete fertilizer was applied in two bands after transplanting at a rate of 750 lbs/A to supply 45 lbs/A N and 135 lbs/A of potash.

The soil test for potash for the test site indicated that no additional potash was necessary with sidedress application. All sidedress treatments were applied at the rate to provide an additional 28 lbs/A of N. Final rates of potash varied according to the sidedress materials, as well as calcium and magnesium. K-Mag was applied at 127 lbs/A to supply 28 lbs/A of potash, comparable to treatment applied with the 14-0-14 treatment.

Yield results were variable, possibly due to excessive rainfall that occurred and no significant differences were observed between the treatments. Average price and grade index were more consistent and doesn't show any practical difference among the treatments. Results of these show the sidedress treatments to be equal and the decision to choose between them should be based on cost, ease of application, and past experience.

<u>Transplant Starter Solutions</u>

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 9).

Table 9. 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 **6-3-18** fertilizer is **6%** N, **3%** 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
21 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 13-0-14 would be supplied by:

231 lbs/ac or $\frac{\text{30 lbs/ac N}}{\text{0.13 N}}$

CROP ROTATIONS AND COVER CROPS

Crop rotation is one of the most effective and inexpensive methods known to increase the efficiency of flue-cured tobacco production. Crop rotation improves soil structure and nutrient balance, increasing the efficiency with which tobacco plants can utilize fertilizer and soil water. Continuous tobacco culture, even in the best of fields, promotes soil erosion and loss of soil structure, which will eventually reduce the capacity of plants in such fields to obtain enough plant food and water for maximum production. In addition, crop rotation is an excellent practice for control of tobacco diseases, insects, and weeds. Not only does crop rotation reduce losses in yield and quality to these pests, but it also reduces the need for expensive pesticides, thus reducing production costs. Crop rotation can, therefore, increase net economic returns to producers by increasing the yield and quality from each field and by reducing the costs of producing flue-cured tobacco.

Special attention should be given to the crop immediately preceding tobacco in the rotation. For example, leguminous crops should not immediately precede flue-cured tobacco because the amount of nitrogen from the crop and the time of its availability varies widely and the following tobacco crop may be affected.

The conservation compliance provision of the Food Security Act of 1985 discourages production of crops in highly erodible fields where the land is not carefully protected from erosion. If crops are produced in such fields without an approved soil conservation system, producers may lose their eligibility for certain U.S. Department of Agriculture program benefits. Contact your local Natural Resources Conservation Service (NRCS) office for more information or for soil conservation planning assistance.

Some examples of rotation plans commonly used in the flue-cured tobacco producing area of Virginia include:

- 1-year rotation
  tobacco followed by small grain or ryegrass cover crop,
- 2-year rotation
  1st year - tobacco followed by small grain and fescue or ryegrass,
  2nd year - grass
- 2-year rotation
  1st year - tobacco followed by small grain
  2nd year - small grain cut for silage and followed by grain sorghum, followed by a winter cover crop,
- 3-year rotation
  1st year - tobacco followed by small grain and fescue.
  2nd year - grass
  3rd year - grass

Seed beds for cover crops should be medium smooth, but not level. Small grains, or a combination of small grains and a grass, should be seeded as soon as possible after the second disking of tobacco roots. Early seeding of the cover crop is important to allow the cover crop to grow as much as possible during the fall. The soil surface should allow a maximum number of tobacco roots to remain exposed, even after seeding the cover crop. Crops and seeding rates for common cover crops are: RYE or WHEAT - 1 to 1 ½ bu/A; BARLEY - 2 to 3 bu/A; DOMESTIC RYEGRASS -20 to 25 lb/A.; TALL FESCUE - 15 to 20 lb/A.; SORGHUM-SUDAN HYBRID - 25 to 30 lb/A; GRAIN SORGHUM - 5 to 7 lb/A. When seeded with small grain, the seeding rate for ryegrass and fescue should be reduced to 15 lb/A.

Cover crops should be plowed under while still young and succulent, generally from mid-to late-March. Temporary nitrogen deficiency, as well as other problems, may be encountered if cover crops are plowed under late in the spring, after the plants within the cover crop have become tall and woody. If the sod of the cover crop is dense, it may be necessary to disk thoroughly in order to tear up the sod prior to plowing.

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 Prime+. However, this is a more labor intensive procedure and worker safety is a significant concern. The majority of growers in Virginia such hand application methods and this probably accounts for at least a third of the total crop grown.

Residues of MH will be an even bigger issue in 2011 given the increased residue levels that occurred on the 2010 crop and the indication by at least one buying company of no residue tolerance for MH in 2011. Severe drought and excessively hot weather played a large role in the elevated residues of 2010 and growers will need to strength their efforts to manage for tobacco for acceptable MH residue levels. Guidelines and suggestions for minimizing MH residues and managing suckers without MH are given below.

Guidelines to Minimize MH Residues

1. 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.
2. Observe the preharvest interval (7 days) following MH application.
3. Consider the addition of flumetralin to a sequential sucker control program. These products may be substituted for the last contact application, tankmixed with MH, or applied alone after MH (usually 3 to 4 weeks later).

Applying flumetralin in place of the last contact has been shown to be effective and can be used to effect MH residues by delaying MH until after the first harvest and reducing the rate to 1 gal per ac (1.5 lbs a.i.) or less.

The MH application should be made soon after the first harvest in order to allow for naturally weathering (rainfall, heavy dews, etc.) of MH residues from leaf surfaces.

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 pretopping 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 (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 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.

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). Hand topping following an over-the-top contact application will generally provide the best level of sucker control as the flower serves to funnel the material down the stalk to contact each leaf axil.

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) apply 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.

Sucker Control Spray Tip Options

Historically, 3 hollow cone nozzles arranged with a TG-5 in the center and a TG-3 on either side have been used for contact sucker control applications. With a spray pressure of 20 psi, a desired application rate of

50 gpa is obtained with a travel speed of approximately 3.8 mph. This speed is too fast for many field conditions in Virginia thus impacting the level of sucker control obtained. Using smaller spray tips, the desired application rate can be obtained at a reduced travel speed. Doing so will improve sucker control by allowing the spray operator to deliver the spray material to every plant and hopefully contacting every leaf axil. The following table gives the spray application rate (gpa) obtain from five different spray tip arrangements across a wide range in travel speeds. An application rate of 50 gallons per acre is optimal, higher rates will increase contact fatty alcohol usage and lower rates will reduce spray effectiveness (maintain at least 45 gal/ac).

Table. 10. Spray application rate with four different spray tip arrangements over a range in travel speeds, calculated based on 48 in. row spacing and 20 psi spray pressure.

	Spray tip arrangement (3 tips per row)			
Speed (mph)	TG-3 (2) TG-5	TG-3 (2) TG-4	TG-2 (2) TG-4	TG-2 (2) TG-3
	gallons per acre			
2.0	93.4	84.8	68.7	60.0
2.2	84.9	77.1	62.4	54.6
2.4	77.9	70.6	57.2	**50.0**
2.6	71.9	65.2	**52.8**	46.2
2.8	66.7	60.5	**49.1**	42.9
3.0	62.3	56.5	45.8	40.0
3.2	58.4	**53.0**	42.9	37.5
3.4	55.0	**49.9**	40.4	35.3
3.6	**51.9**	47.1	38.2	33.3
3.8	**49.2**	44.6	36.1	31.6
4.0	46.7	42.4	34.3	30.0
4.2	44.5	40.4	32.7	28.6
4.4	42.5	38.5	31.2	27.3
4.6	40.6	36.9	29.9	26.1
4.8	38.9	35.3	28.6	25.0
5.0	37.4	33.9	27.5	24.0

Calibration of a sprayer using the 1/128th acre method is relatively easy. Using this method for a row spacing of 48 inches, the travel time with a tractor in the field is recorded for a distance of 85 ft. Collect water from the spray tips at operating pressure for the length of travel time (85 ft). The amount of water collected from all three nozzles of one row is equal to the spray application rate in gallons per acre. The travel time for the 85 ft calibration distance increases from 16 seconds for 3.6 mph to 22 seconds for 2.6 mph. Additional information on using the 1/128th acre method of calibration and determining travel speeds may be found in this production guide.

Reduced MH and MH-Free Sucker Control Test

Results from a sucker control test conducted at the Southern Piedmont Center in 2007 are presented in Table 11. This set of treatments was part of a larger test conducted to evaluate reduce MH and MH-free sucker control treatments. Results are expressed in terms of percent sucker control which is calculated based on the weight of sucker compared to a treatment receiving no chemical sucker control (topped-not-suckered). All treatments were applied using 2 TG-3 tips and 1 TG-5 over the center of the row, except treatment nos. 5 and 8. These treatments were applied with 2 TG-2 tips and a TG-6 to direct a greater proportion of the spray material directly over the plant stalk (60% compared to the typical 47% with the TG-3's and 5). Travel speed was reduced slightly to provide for the same application rate (50 GPA) with the two spray tip arrangements. The two treatments with 1.5 gal of MH-30 (2.25 lbs a.i. per ac) provided the poorest sucker control at approximately 30%. The tankmix of 1.5 gal MH-30 and 2 qt/ac of the dinitroaniline, Flupro, significantly improved sucker control to greater than 90%. Similar levels of control were obtained from treatments with reduced rates of MH in combination with Flupro (Trt. nos. 1 and 4). Omitting MH entirely and applying 2 qt/ac of Flupro (Trt. nos. 5 and 6) did not provide satisfactory control when applied once, but when split in two application of 1 qt each (trt. no. 2) did provide excellent control. The third and fourth spray applications in this test were separated by 18 days with the first harvest occurring during this time. No differences were observed between treatments comparing applications using TG3's and a 5 with TG-2's and a 6. Results of the tests reinforce the fact that the tankmix of 1.5 gal MH -30 with 2 qt of a dinitroaniline is the standard for sequential sucker control. The results also show promise with regard to the possibility of reducing the rate of MH when used in conjunction with a dinitroaniline (Trt. nos. 1 and 4). These and similar reduced MH or MH-free treatments need to be evaluated further under a wider range of conditions to ensure their reliability. Reducing or eliminating the systemic control obtained from MH will require greater management to ensure satisfactory results from dinitroanilines. Proper application technique and timing will be critically important to minimize the growth of escape suckers that can occur.

Table 11. Reduced MH and MH Free Sucker Control Test Conducted at the Southern Piedmont Center, Blackstone, Va. 2007.

Trt. No.	Application 1st	2nd	3rd	4th	Percent Sucker Control[1]
1	FA[2] 4%	FA 5%	Flupro 1 qt	MH-30 & Flupro 3 qt and 1 qt	97.9 a
2	FA 4%	FA 5%	Flupro 1 qt	Flupro 1 qt	96.6 a
3	FA 4%	FA 5%	MH-30 & Flupro 1.5 gal and 2 qt		91.5 a
4	FA 4%	FA 5%	Flupro 2 qt	MH-30 1 gal	90.0 a
5	FA 4%	FA 5%	Flupro 2 qt	*(2 TG-2 and 1 TG-6)*	69.4 b
6	FA 4%	FA 5%	Flupro 2 qt		66.9 b
7	FA 4%	FA 5%	MH-30 1.5 gal	*(2 TG-2 and 1 TG-6)*	32.1 c
8	FA 4%	FA 5%	MH-30 1.5 gal		28.0 c

[1]Percent sucker control values followed by the same letter are not significantly different.
[2]FA= contact fatty alcohol (Sucker Plucker was used in this test but other products could be substituted with similar results).

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 <u>Power Spray</u> 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 <u>Hand Application</u> 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	<u>Power Spray</u> 2 qt/a of flumetralin Apply 50 gal of spray material per acre. <u>Hand Application</u> 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 <u>Power Spray</u> 15 - 20 psi using 3 solid cone nozzles per row (i.e. 1 TG-5 and 2 TG-3's) <u>Hand Application</u> 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
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 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

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

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

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

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.

DISEASE CONTROL IN TOBACCO GREENHOUSES

Avoid seeding tobacco greenhouses any earlier than necessary. Eliminate any volunteer tobacco plants. Plants closely related to tobacco (tomatoes, peppers, etc) should not be grown in greenhouses used for transplant production.

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

If tobacco mosaic (TMV) may have occurred in the previous year, greenhouse surfaces such as side-curtains, center walkways, and the 2x6 boards that support the float bays should be disinfected. A 1:10 solution of household bleach and water is sufficient for these purposes, as are most disinfectants. There is no need to spray the purline supports or the plastic covers over the greenhouse. Float trays used when TMV may have been present should be washed and cleaned thoroughly before being fumigated. Mosaic has a number of weed hosts (horsenettle, ground cherry) which should be removed from the vicinity of tobacco greenhouses.

Float trays should be cleaned and then fumigated with methyl bromide or aerated steam (140^0F to 175^0F for 30 minutes) to minimize *Rhizoctonia* damping-off and sore shin. Dry trays should be loosely stacked no more than 5 ft high and completely enclosed in plastic. Use one pound of methyl bromide per 330 cubic feet (400 trays). Trays should be fumigated 24 to 48 hours, then aerated for at least 48 hours before use. Be sure to read the label for space fumigation and follow it exactly.

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

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

To avoid spreading TMV, mower blades and decks should be sanitized with a 1:1 bleach: water solution between greenhouses and after each clipping. Plant debris left on trays after clipping is one of the primary causes of collar rot problems. High vacuum mowers should be used to clip tobacco seedlings. Clippings, unused plants, and used media should be dumped at least 100 yards from the greenhouse.

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

SPECIFIC DISEASES IMPORTANT IN VIRGINIA

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

Black shank is caused by a fungus-like pathogen that lives in soil and attacks tobacco roots and stalks. Table 3 presents black shank resistance ratings for flue-cured tobacco varieties. *Virginia tobacco producers who have used varieties possessing the Php gene should assume their fields contain race 1 of the black shank pathogen*. Growers planting black shank problem fields in 2012 should seriously consider preventative soil fungicide use in addition to planting the highest black shank resistance available. Remember that while soil fumigants provide good to excellent control of Granville wilt and nematodes, they are generally not effective for black shank control.

Granville (Bacterial) Wilt is caused by a soil-inhabiting bacterium that invades tobacco plants through roots and often kills the entire plant. The pathogen can also invade tobacco plants through wounds, so early and shallow cultivation and topping by hand can help reduce the 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 4, 5, and 6).

Table 3. Reactions of flue-cured tobacco varieties to Black Shank.

	% Survival (Race 1)[2]		2008-2010 Yield Index	
	2011	2008-2011	Black Shank (Race 1)	No Black Shank
Varieties with the Php gene[1]				
SP 225	65	83	73	91
SP227	76	72	68	85
NC 606	45	66	65	102
NC 471	55	69	62	93
PVH 1452	65	60	60	103
SP 168	67	60	56	96
SP 220	68	60	59	102
CC 67	65	59	59	100
NC 196	60	54	58	104
NC 71	45	46	50	112
CC 304	55	54	48	90
PVH 1118	35	48	48	90
CC 37	40	45	47	100
CC 700	46	45	46	102
NC 299	38	44	46	107
NC 291	38	38	41	106
CC 27	30	34	37	107
GF 318 [4]	**37**	**34**	**36**	**102**
RG H51	34	35	35	98
NC 72	30	33	35	106
NC 102	30	31	31	100
NC 297	26	29	30	106
NC 92 [4]	**16**	**24**	**23**	**96**
Varieties without the *Php* gene[1]				
SP 236	77	85	75	88
K 346	65	76	70	90
K 394	43	65	66	96
CC 65 [4]	**68**	**59**	**64**	**105**
CC 33	36	51	53	103
CC 13	27	45	48	112
K 149	32	49	48	92
PVH 2110	11	39	41	110
K 326	14	27	29	103

[1] Varieties with the *Php* gene possess high to 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 near 2nd harvest without a soil fungicide. Results are averages from 2008-2011 field experiments conducted by Clemson and North Carolina State Universities as part of the Regional Flue-Cured Tobacco Variety Evaluation Program.
[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 2008-2011 Virginia OVT test conducted at the Southern Piedmont AREC, Blackstone. Yield indexes for "Black Shank (race 1)" = yield index without black shank multiplied by the average estimated plant stand during harvest (% Survival/100).
[4] New variety; ratings are based upon the more limited data available.

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, CC 304, GF 318, NC 102, and NC 297 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.

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

Table 4. Reactions of flue-cured tobacco varieties to Granville Wilt.

Varieties with the *Php* gene[1]	% Survival[2]		2008-2011 Yield Index	
	2010	2008-2010	With Granville Wilt	No Granville Wilt
CC 27	95	87	94	107
CC 37	96	88	92	105
SP 227	97	93	90	97
SP 220	98	93	89	96
PVH 1452	98	86	85	99
NC 196	85	77	83	107
NC 471	97	89	80	90
NC 606	92	82	80	97
NC 72	88	73	77	106
CC 67	100	77	77	100
NC 299	93	74	76	102
SP 225	98	86	75	87
SP 168	93	81	74	92
CC 700	80	71	74	105
NC 297	79	70	73	105
NC 71	82	68	72	106
PVH 1118	80	69	72	105
NC 291	79	65	70	107
NC 102	87	69	70	101
RG H51	80	66	66	101
Varieties without the *Php* gene[1]				
K 149	75	81	81	100
K 346	93	82	75	92
CC 33	85	72	74	103
CC 13	90	70	73	104
SP 236	89	81	71	88
PVH 2110	91	67	71	105
K 326	46	58	63	108
CC 35	43	38	43	113
K 394	50	31	32	103

[1] The *Php* gene provides high to very high resistance to race 0 of the black shank pathogen, but no resistance to Granville Wilt.
[2] Average % Survival near 2nd harvest without a soil fumigant. Results are averages from 2008-2010 field experiments conducted by Clemson University as part of the Regional Flue-Cured Tobacco Variety Evaluation Program.
[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 2010 Virginia OVT test conducted at the Southern Piedmont AREC, Blackstone. Yield indexes "With Granville Wilt" = yield index without

disease multiplied by the average estimated plant stand during harvest (% Survival/100).
[4] Based upon the more limited data available.

Table 5. Results from 2010-2011 North Carolina on-farm Granville Wilt resistance tests.[1]

Varieties with the *Php* gene[2]	%Survival[3]			Relative Yield Index[4]		
	2011	2010	2010-11	2011	2010	2010-11
CC 37	76	73	74	79	76	77
PVH 1452	74	70	72	75	71	73
SP 225	84	.	.	74	.	.
CC 67	72	81	76	72	81	76
GL 368	63	40	51	.	.	.
NC 196	56	56	56	59	59	59
CC 304	57	.	.	51	.	.
NC 92[5]	**55**	.	.	**53**	.	.
GF 318[5]	**50**	.	.	**53**	.	.
GL 338	42	56	49	42	56	49
PVH 1118	34	24	29	34	24	29
Varieties without the *Php* gene[2]						
CC 33	66	50	58	68	51	60
PVH 2110	62	44	53	66	46	56
K 346	71	.	71	65	.	.
CC 13	46	37	41	49	39	44
K 326	37	.	37	40	.	.
K 394	34	17	25	34	17	26

[1] Disease data courtesy Dr. Mina Mila, Dept of Plant Pathology, North Carolina State University.
[2] The *Php* gene provides high to very high resistance to race 0 of the black shank pathogen, but no resistance to Granville wilt.
[3] Average % Survival near 2nd harvest without a soil fumigant. Results are averages from on-farm experiments conducted as part of the Regional Flue-Cured Tobacco Variety Evaluation Program.
[4] 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 2008-2011 Virginia OVT tests conducted at the Southern Piedmont AREC, Blackstone. Yield indexes "With Granville Wilt" = yield index without disease multiplied by the average estimated plant stand during harvest (% Survival/100).
[5] New cultivar; ratings based upon the more limited data available.

Table 6. Performance of selected flue-cured tobacco varieties under low Granville Wilt disease pressure. Data from on-farm tests in Brunswick County, VA in 2009-2011.

	% Survival[2]				Relative Yield Index[3]				
	2011	2010	2009	2009-2011	2011	2010	2010-2011	2009	2009-2011
Varieties with the *Php* gene[1]									
NC 196	98	86	89	91	104	91	97	94	96
CC 37	99	100	96	98	103	104	103	100	102
GF 318[4]	**97**	.	.	.	**103**	.	.	.	.
NC 299	98	83	90	90	101	85	93	93	93
CC 27	94	92	.	93	101	99	100	.	.
CC 67	100	99	.	99	100	99	99	.	.
PVH 1452	99	94	94	96	100	95	98	95	97
SP 225	.	99	99	99	.	88	.	88	.
SP 227	97	95	95	96	91	89	90	89	90
NC 71	.	.	66	.	.	.	.	71	.
Varieties without the *Php* gene[1]									
CC 13	97	.	.	.	102	.	.	.	.
CC 33	94	83	.	89	97	85	91	.	.
K 326	86	77	.	82	92	83	87	.	.
CC 35	63	.	.	.	70	.	.	.	.
SP 236	.	.	79	.	.	.	.	70	.

[1] The *Php* gene provides high to very high resistance to race 0 of the black shank pathogen, but no resistance to Granville wilt.
[2] Average % Survival near 2nd harvest without a soil fumigant. Results are averages from 2009-2011 field experiments conducted by Clemson University as part of the Regional Flue-Cured Tobacco Variety Evaluation Program.
[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 2009-2011 Virginia OVT tests conducted at the Southern Piedmont AREC, Blackstone. Yield indexes "With Granville Wilt" = yield index without disease multiplied by the average estimated plant stand during harvest (% Survival/100).
[4] New cultivar; ratings based upon the more limited data available.

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*. The southern root-knot nematode (*Meloidogyne incognita*) is the most common species of root-knot nematode in Virginia, but other types of root-knot can also be present in damaging numbers. *Most flue-cured tobacco varieties currently grown are resistant to the Southern root-knot nematodes, with the exception of K 394*. Root galling on other tobacco varieties indicates the presence of other species or races of root-knot nematode. Rotation intervals should be increased as long as possible and soil fumigation may be advisable when galling has been observed on root-knot resistant varieties. ***Flue-cured tobacco varieties CC 13, CC 33, CC 37, and CC 67 claim some resistance against these other species of root-knot.*** Rotating tobacco with grasses or small grains reduces populations of tobacco cyst and root-knot nematodes, but care should be taken to plant nematode resistant cultivars of some rotation crops (Table 1). Preplant nematicide use may be necessary when root-knot nematode populations are high, as indicated in the following table:

INTERPRETING ROOT-KNOT INFESTATION LEVELS

		Nematodes/500 cc of soil		
Risk of Crop Loss	% Roots Galled	Fall Sample	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'

Varieties with the Php gene reduce TCN populations dramatically, although a recommended nematicide may be necessary to produce acceptable yield and quality when the number of TCN juveniles and eggs in soil samples exceeds 1,000 per 500 cc of soil (Table 3).

Forage legumes are often good hosts for root-knot nematodes. Crop rotation may not reduce lesion nematode populations as effectively as it does for tobacco cyst or root-knot nematodes. However, a single year of forage or grain pearl millet can reduce lesion nematode numbers similarly to soil fumigation. *Nematicide use may be profitable when a soil assay detects only 50-100 lesion nematodes/500cc of soil.*

Nematicides should always be used in conjunction with resistance, rotation, and early root and stalk destruction. Poor control of nematodes and soil insects can also increase disease losses in fields infested with black shank and Granville wilt.

Contact nematicides (such as Temik) are no longer registered for use in tobacco fields. If a susceptible variety will be grown in a field where populations of lesion, root-knot, or tobacco cyst nematodes are high, the field should be fumigated at least 3 weeks before transplanting.

APPLICATION METHODS

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

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 should be repeated 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 flat-fan spray tips and spray volumes between 25 and 40 gallons per acre. Field sprays for leaf diseases should generally be performed using hollow cone tips to apply a fine spray of 20-100 gallons per acre to maximize coverage as plants increase in size. Spray pressures should generally range between 40-100 psi. Both the tops and bottoms of leaves need to be covered. Use of drop nozzles will significantly improve disease control after layby by improving spray coverage on bottom leaves, where foliar diseases are usually concentrated.

Fumigation: - F-Row - Inject fumigant 6 to 8 inches deep with one chisel-type applicator in the center of the row. Soil should be sealed in the same operation by bedding the fumigated row area with enough soil to bring the soil surface 14 to 16 inches above the point of injection. **F-Broadcast** - Space chisels 8 inches apart and inject fumigant 10 to 12 inches below the soil surface. Soil should be sealed immediately with a roller, drag, or similar piece of equipment.

PRODUCT LABELS FOR MOST SOIL FUMIGANTS CHANGED IN 2011. The 2011 labels for Telone C-17, Chlor-O-Pic, and Pic+ included dramatic new requirements. Be sure that you read and understand these labels well before you plan to fumigate in 2012. Study particularly the requirements for personal protective equipment and preparation of a “fumigant management plan” that must be completed *before* you fumigate and in your possession when you are fumigating.

Additional new requirements are coming in 2012, but are not expected to become effective until sometime in early summer of 2012. However, all growers who fumigate should be preparing to allow for buffer zones and other important new requirements that will become mandatory when the new labels become effective.

After fumigation, leave soil undisturbed for 7-14 days. Cold, wet soil slows diffusion of fumigants, so wait longer before working soil under such conditions. Transplants will be injured if fumigant is still present at transplanting, so soil should be aerated after the exposure period. Planting should be safe when the fumigant can no longer be smelled in the soil root zone. This condition is usually reached (depending upon temperature and moisture) within three weeks after fumigations. To hasten aeration (especially after cold, wet weather): 1) **Row** – use a chisel in the bed without turning the soil; 2) **Broadcast** – plow or cultivate above the depth of the treatment zone; **Caution**: avoid contaminating fumigated soil with untreated soil.

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 7. DISEASES OF TOBACCO SEEDLINGS

Disease	Material	Rate
Angular Leaf Spot or Wildfire *(Pseudomonas)*	Agri-mycin 17, Firewall, Fire-wall 17WP, 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.		
Anthracnose *(Colletotrichum gloeosporoides)*	Dithane DF Rainshield	0.5 lb/100 gal (1 level tsp/gal)
Blue Mold *(Peronospora tabacina)*; **Target Spot** *(Thanatephorus cucumeris)*	Manzate ProStick Penncozeb 75DF	
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.		

Table 7. DISEASES OF TOBACCO SEEDLINGS (Cont'd)

Disease	Material	Rate
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/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.		
Pythium Root Rot (*Pythium* spp.)	Terramaster 35WP	2 oz/100 gal of float bed water
	Terramaster 4EC	Preventative: 1 fl oz/100 gal Sequential: 1 fl oz/100 gal 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 2.8 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.		
Tomato Spotted Wilt Virus (TSWV)	Actigard 50WG	1-2 oz/100,000 plants (~350- 288-cell trays)
Remarks: *Must submit liability waiver to receive a copy of the label, which is required for use.* One foliar application in the greenhouse 5-7 days prior to transplanting in sufficient water to ensure good coverage (~6 gal/1,000 sq. ft.); **use of accurate rate is critical to avoid crop injury.** In general, a 10-15% stand loss due to TSWV should be expected before considering application of Actigard to tobacco seedlings. Use of systemic insecticides such as imidacloprid or thiamethoxam as well as Actigard will significantly improve control of TSWV. Tank-mixtures are not recommended, but product may be left on foliage or washed off into the root ball.		

FIELD DISEASES OF TOBACCO

Root and Stem Diseases

Product	Rate/A	Application Method[1]	Disease[2] Black Shank	Disease[2] Granville Wilt
Ridomil Gold SL	1-3 pt	Preplant	F	---
Ultra Flourish	2-6 pt	Preplant	F	---
MetaStar 2E AG	4-12 pt	Preplant	F	---
Ridomil Gold SL	1 pt + 1 pt	Preplant + layby	VG	---
Ultra Flourish	2 pt + 2 pt	Preplant + layby	VG	---
MetaStar 2E AG	4 pt + 4 pt	Preplant + layby	VG	---
Ridomil Gold SL	4-8 fl oz + 1.0 pt	TPW[3] + 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	Preplant + 1st cultivation + layby	VG	---
Ultra Flourish	2 pt + 2 pt + 2 pt	Preplant + 1st cultivation + layby	VG	---
MetaStar 2E AG	4 pt + 4 pt + 4 pt	Preplant + 1st cultivation + layby	VG	---
Telone C-17	10.5 gal	F-Row	P-F[4]	G
Chlor-O-Pic	3 gal	F-Row	P-F[4]	G
Chloropicrin 100	3 gal	F-Row	P-F[4]	G
Pic Plus	4 gal	F-Row	P-F[4]	G

[1]Preplant – broadcast, preplant-incorporated spray; Transplant water – 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, 6 pt of Ultra Flourish, or 12 pt of Meta Star 2E AG per acre.

[2]Control rating – F=fair; G=good; VG=very good. (-) – 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. There is a risk of temporary plant injury from TPW application at lower rates of water per acre. Pre-mixing Ridomil Gold in a tank from the TPW nurse or source tank also reduces risk of plant injury.

[4]Fumigants will not control black shank without use of a soil fungicide, but may improve control from a single application of a black shank fungicide.

FIELD DISEASES OF TOBACCO (Cont'd)

Foliar Diseases

Disease	Material	Rate[1]	Application Method[2]
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 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.			
Blue mold *Peronospora tabacina*)	Aliette	2.5-4.0 lb/A	Foliar
Remarks: No more than 5 sprays allowed, 3 day pre-harvest interval; don't tankmix.			
Blue mold *Peronospora tabacina*)	Ridomil Gold EC Ultra Flourish MetaStar 2E AG	0.5-1 pt + 0.5 pt/A 1-2 pt + 1 pt/A 2-4 pt + 2pt	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*)	Acrobat 50WP + Dithane DF Rainshield, Manzate ProStick, or Penncozeb 75 DF Forum + Dithane DF Rainshield Manzate ProStick, or Penncozeb 75 DF	7.0 oz/100 gal water + 2.0 lb/100 gal water 7.0 fl oz/100 gal water + 2.0 lb/100 gal water	Foliar Spray
Remarks: Begin sprays when the Blue Mold Advisory predicts conditions favorable for disease. Continue applications on a 5-7 day interval until the threat of disease subsides. Apply 20 to 30 gal/A of spray solution during the first several weeks after transplanting and gradually increase spray volume as the crop grows. Spray volumes should reach 40 gal/A by layby and should range between 80 and 100 gal/A on tobacco ready to be topped. Do not exceed 2.5 lb/A of Acrobat per application or 10 lb/A per season. Do not apply after the early button stage or within 21 days of the first harvest.			

FIELD DISEASES OF TOBACCO (Cont'd)

Foliar Diseases

Disease	Material	Rate[1]	Application Method[2]
Blue mold (*Peronospora tabacina*); Frogeye (*Cercospora nicotianae*); **Target Spot** (*Thanatephorus cucumeris*)	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; don't spray Quadris "back-to-back" for blue mold, but alternate with another fungicide; spray sufficient water volume for complete coverage and canopy penetration; may enhance weather flecking, but this shouldn't affect yield or quality; up to 4 applications/year allowed; but residues are a concern of the tobacco industry; may be applied up to the day of harvest; tankmixing with insecticides formulated as ECs or containing high amounts of solvents may cause some crop injury.

[1]Use higher rates of protectant fungicides for mature plants.

[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.

TOBACCO NEMATODES

		Nematodes [1]	
Product	**Rate/A, Application Method[2]**	**Root-Knot and Others**	**Tobacco Cyst**
Fumigants			
Chlor-O-Pic	3- 4 gal, Row	E	G
Metam CLR	25 gal, Row	---	G
Pic Plus	4.2 gal, Row	E	G
Telone II	9-10 gal, Row	E	G
Telone C-17	10.5 gal, Row	E	G

[1] Control ratings: E=Excellent; G=Good; F=Fair; P=Poor; (---) =no control or not labeled. Use higher rates for higher nematode populations or for heavier soils.

[2] Row=inject 8 inches deep in row with single shank - 21-day waiting period before planting.

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.
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

Charles S. Johnson, Extension Plant Pathologist, Tobacco

Good weed control uses crop rotation, early root and stalk destruction, cultivation, and appropriate use of herbicides. Application of a 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 obtain full season weed control. 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. 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. Use in 20 to 40 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. Poast should be applied at 5 to 20 gallons of water per acre. Never leave a spray mixture in a sprayer overnight!

<u>Herbicide Incorporation</u> - 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 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) performs 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

<u>Effect of Preplant Applications on Early Season Tobacco Growth</u> - 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.

<u>Effects of Herbicides on Rotation Crops</u> - 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

Preplant Herbicides (No-till) Apply the herbicide in an even broadcast application, avoiding spray overlap. Use even, fan-type, flood-jet, or raindrop nozzles. Spartan Advance and Spartan Charge both contain the same active ingredient (sulfentrazone) as Spartan 4F, but also contain another herbicide. Spartan Advance also contains glyphosate, the active ingredient in Roundup, for example. Spartan Charge is a "premix" herbicide that contains carfentrazone (the active ingredient in Aim), as well as sulfentrazone. Both may be either surface-applied or incorporated shallowly (less than 2 inches) before transplanting, but not afterwards. *Be aware that tobacco leaves will burn if contacted by sprays containing Spartan Advance or Spartan Charge*. The following tables present rates of Spartan Advance, Spartan Charge, Spartan 4F, and Aim that deliver equivalent amounts of active ingredient. Rates for glyphosate products are not presented because of the numerous product formulations used for this ingredient:

SPARTAN ADVANCE CONVERSION TABLE	
Rate of Spartan Advance	Rate of Spartan 4F
32 fl oz/acre	4.5 oz/acre
43 fl oz/acre	6.0 oz/acre
57 fl oz/are	8.0 fl oz/are
72 fl oz/are	10.1 fl oz/are
86 fl oz/are	12.0 fl oz/are

SPARTAN CHARGE CONVERSION TABLE		
Rate of Spartan Charge	Equivalent Rate of Spartan 4F	Equivalent Rate of Aim EC
3.8 fl oz/A	3.0 fl oz/A	0.65 oz/A
4.5 fl oz/A	3.5 fl oz/A	0.75 oz/A
5.7 fl oz/A	4.5 fl oz/A	1.00 oz/A
7.6 fl oz/A	6.0 fl oz/A	1.3 oz/A
10.2 fl oz/A	8.0 fl oz/A	1.8 oz/A
12.8 fl oz/A	10.1 fl oz/A	2.2 oz/A
15.2 fl oz/A	12.0 fl oz/A	2.7 oz/A

Preplant Herbicides (PRE, PPI) Apply herbicide(s) 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.

An on-farm yellow nutsedge control test conducted in Halifax County in 2009 found the following in terms of weed control from equivalent rates of Spartan Charge versus Spartan 4F:

	% Nutsedge Control		
Herbicide Treatment	4 June	7 July	9 Sept
No herbicide	0	0.2	4
Spartan 4F, 4.6 fl oz/A	50	50	56
Spartan Charge, 5.8 fl oz/A	48	54	32
Spartan 4F, 6 fl oz/A	36	61	44
Spartan Charge, 8.0 fl oz/A	61	76	71
Spartan 4F, 7.9 fl oz/A	72	82	72
Spartan Charge, 9.0 fl oz/A	68	85	74
Spartan 4F, 10.1 fl oz/A	60	80	86

A 2010 field experiment found the following in terms of relative weed control with the two Spartan formulations. In reviewing these results, you should be aware that conditions were extremely dry, and these conditions may have reduced the weed control that could be expected under more common weather in Southside Virginia:

Herbicide,	% Weed Control		Herbicide,	% Weed Control	
Rate/A	June 22	Aug 9	Rate/A	June 22	Aug 9
Untreated Control	68	3	Untreated Control	68	3
Spartan 4F, 8 fl oz	83	8	Spartan Charge, 10 fl oz	73	8
Spartan 4F, 10 fl oz	83	7	Spartan Charge, 13 fl oz	87	10
Spartan 4F, 12 fl oz	82	0	Spartan Charge, 15 fl oz	88	3

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 can 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	E	P-F	E	E	E	E	E	E	G	G	P
Devrinol	G	P	F	E	E	G	E	E	F	-	N
Poast	F-G	G	E	G	F	E	E	G	E	E	N
Prowl or Pendimax	G	P	G	E	E	G	E	E	G	G	N
Spartan	F	P	F	F	F	F	F	F	F	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	P	F	P-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 or Pendimax	G	P	P	P	G	P	G	P	P	P	P	P
Spartan	G	F-G	F	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[1] Texture	Chemical Lbs Active Ingredient/A	Product per Acre	Applic.[2] 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
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 care 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 2.0 pt 2.7 pt	OT
Remarks: Use the higher rate for heavy weed pressure or heavy soils. Transplants should be placed below the treated area. Do not use in plant beds. Stands of grass cover crops may be reduced if planted within 9 months of Command 3ME application. Do not graze or feed cover crops planted less than 9 months after Command 3ME 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 Coarse Medium Fine	napropamide 1.0 1.0-1.5 2.0 1.0 1.0-1.5 2.0	Devrinol DF 2.0 lb 2.0-3.0 lb 4.0 lb Devrinol 2E 2 qt 2-3 qt 4 qt	PPI, OT, Layby PPI only
Remarks: For PPI application, incorporate the same day as applied. Small grain injury may result from PPI application method.				

WEED CONTROL IN FLUE-CURED TOBACCO FIELDS (continued)

Weed Problems	Soil[1] Texture	Chemical Lbs Active Ingredient/A	Product per Acre	Applic.[2] Method
Grass weeds and volunteer small grain	All types	sethoxydim	Poast	Postemergence
	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. 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,		Pendime-thalin	Prowl 3.3 EC or Pendimax 3.3	
crabgrass,	Coarse	0.74-0.99	1.8 – 2.4pt	PPI only
crowfoot	Medium	0.74-1.24	1.8 - 3.0 pt	
grass, Florida pusley,	Fine	0.99-1.24	2.4 - 3.0 pt	
foxtails,	Coarse	0.50 – 0.74	1.2 – 1.8 pt	Layby only
goosegrass,	Medium	0.74 – 0.99	1.8 – 2.4 pt	
johnsongrass from seed,	Fine	0.74 – 0.99	1.8 – 2.4 pt	
lambsquarters,			Prowl H_20 3.8EC	
panicums,	Coarse	0.95	2.0 pt	PPI only
pigweed,	Medium	0.95 – 1.19	2.0 – 2.5 pt	
purslane, signalgrass.	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: For silt and silt loam soils, use 2.4 – 3.0 pt/A of Prowl 3.3EC or 2.5 pt/A of Prowl H2O for PPI applications. *Rates are for broadcast application and must be adjusted for banded sprays based on the width of the intended spray band and soil texture.* Applied according to directions and under normal growing conditions, Prowl should not harm transplanted tobacco, 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 and winter barley are no-till planted in the fall after spring application of Prowl. Don't feed forage or graze livestock for 75 days after planting wheat or barley in Prowl-treated land.

WEED CONTROL IN FLUE-CURED TOBACCO FIELDS (continued)

Weed Problems	Soil[1] Texture	Chemical Lbs Active Ingredient/A	Product per Acre	Applic.[2] 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	After bedding, before transplanting
	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	10.1-12 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	12 fl oz	

Remarks: %0M = % organic matter. Apply this product 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 Spartan 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[1] Texture	Chemical Lbs Active Ingredient/A	Product per Acre	Applic.[2] Method
Hairy galinsoga, goosegrass, groundcherry, jimsonweed, lambsquarters, morning-glory, wild mustard, nightshade, nutsedge, orchardgrass, pigweed, prickly sida, broadleaf signalgrass, Pennsylvania smartweed.		sulfentrazone + carfentrazone	Spartan Charge	Burndown, preplant surface application, PPI
	<u>Coarse</u>			
	<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	
	<u>Medium</u>			
	<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	
	<u>Fine</u>			
	<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.*

WEED CONTROL IN FLUE-CURED TOBACCO FIELDS (continued)

Weed problem	Soil[1] Texture	Chemical; lbs Active Ingredient/A	Product Per Acre	Applic.[2] Method
Pre-Emergent: Same as Spartan 4F. Check label for uncommon weeds, as well as weed control spectrum for Post-Emergent, Pre-Plant Burndown applications.		sulfentrazone + glyphosate	Spartan Advance	Burndown, preplant surface application, PPI
	Coarse			
	<1.5%OM	0.14-0.19 + 1.01-1.36	32-43 fl oz	
	1.5-3%OM	0.19-0.25 + 1.36-1.80	43-57 fl oz	
	>3%OM	0.25-0.32 + 1.80-2.27	57-72 fl oz	
	Medium			
	<1.5%OM	0.19-0.25 + 1.36-1.80	43-57 fl oz	
	1.5-3%OM	0.25-0.32 + 1.80-2.27	57-72 fl oz	
	>3%OM	0.32-0.38 + 2.27-2.71	72-86 fl oz	
	Fine			
	<1.5%OM	0.25 + 1.80	57 fl oz	
	1.5-3%OM	0.32 + 2.27	72 fl oz	
	>3%OM	0.38 + 2.71	86 fl oz	

Remarks: Use higher rates within soil texture ranges when soil pH<7. An additional grass herbicide will be required for broad spectrum and optimum grass control. May be surface applied or preplant incorporated (less than 2 inches) from 14 days to 12 hours before transplanting. Knock-down pre-formed beds before applying the product. If not incorporated, 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. **Read precautionary statements.**

[1]When the soil has less than 1% organic matter, use the rate for the coarse soil texture recommendations. Coarse - sands, loamy sands, sandy loams; Medium - sandy clay loams, silts; Fine - clay loams, silty clay loams, clays.

[2]PPI -=Preplant incorporated. Delay in growth may result under adverse conditions and/or when poor application practices have been used. OT = Over-the top after transplanting as a band or broadcast application. Layby = Application of herbicide in row middle after last cultivation. Preplant burndown = broadcast spray before transplanting in conservation tillage production system. Shielded or hooded spray = application to row-middles only using sprayer with shields or hoods to prevent spray contact to tobacco leaves. Directed spray = spray directed toward row-middles and surface of row-beds after sequential harvesting has removed sufficient leaves that spray will not contact remaining crop leaves.

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

Paul J. Semtner, Retired 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. Some also transmit several important tobacco diseases.

Integrated pest management (IPM) 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. A certain amount of insect damage does not reduce crop value enough to pay for the cost of treatment. In addition, 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.

<u>Cultural controls</u>

Several cultural practices help reduce insect infestations and decrease the need for insecticide applications. The following cultural practices aid in the management of insect pests on tobacco.

1. **Early land preparation.** Plowing at least 4 weeks before transplanting reduces cutworm infestations and may aid in wireworm control.

2. **Use of recommended nitrogen rates**. Excessive rates of nitrogen fertilizer may delay maturity and make tobacco a more favorable host for hornworms and aphids after topping.

3. **Adjustments in transplanting date.** This reduces tobacco susceptibility to insect pests. 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. Aphid infestations are usually most serious on tobacco transplanted near the middle of the transplanting period.

4. **Destruction of greenhouse transplants as soon as practical after transplanting is completed.** This practice keeps aphids and other insects from developing high populations on the transplants and migrating to nearby tobacco fields.

5. **Management of 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 heavily infested with grasshoppers.

6. **Topping tobacco in the button or early flower stage.** This practice eliminates food sources for budworms and makes the crop a less desirable host for aphids and hornworms.

7. **Obtaining effective sucker control.** Sucker control reduces food sources for hornworms, budworms, and aphids.

8. **Destroying crop residues immediately after harvest is completed.** Stalk cutting and root destruction reduces feeding and overwintering sites for hornworms, budworms, and flea beetles. This practice is most effective when done on a community-wide basis.

9. **Use crop rotations that reduce infestations of soil-inhabiting insects.** 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.** Use conservation tillage practices to manage insect infestations. Conservation tillage strategies including no-till and strip-till reduces aphid and flea beetle populations, but may increase problems with cutworm, vegetable weevil, and slug infestations.

Natural Control

Beneficial organisms, including predators, parasites and pathogens, help control several insect pests. 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 feeds inside the caterpillars. When these larvae mature, they emerge through the backs of the hornworms and form egg-like cocoons. 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, and syrphid fly larvae. Bright red midge larvae also feed on aphids after topping. The pathogenic fungus, *Pandora neoaphids*, 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), flubendiamide (Belt), methomyl (Lannate), pymetrozine (Fulfill), and spinosad (Tracer). Transplant water and tray drench applications of imidacloprid (Admire Pro and various generics) and thiamethoxam (Platinum) have limited direct impact on beneficials.

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 (>99%) 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 of seedlings.
- **Crickets and earwigs** often destroy newly emerged tobacco seedlings, reducing stands and initial growth.
- **Shoreflies**, tiny flies that look like small houseflies, are frequently numerous in greenhouses. Their larvae (tiny maggots) feed on young seedlings and may reduce stands during the first 2 weeks after germination.
- **Mice** remove the seeds from float trays seriously reducing plant stands. If stand loss is severe, the entire greenhouses may require reseeding.
- **Green June beetle grubs** uproot seedlings in the trays sitting on the soil surface in greenhouses with overhead watering systems.

- **Cutworms, crickets, 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 appears to do little harm unless populations are very high.
- **Vegetable weevil** adults and larvae often feed on the leaves and stems destroying the buds of seedlings.
- **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.

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, rocks, wood, metal, and other items that provide food and shelter for insects and other pests.
- Do not plant fall and winter gardens near the greenhouse. Aphids can survive on various vegetables and related weeds during the winter and develop winged forms that fly into greenhouse and establish colonies on tobacco seedlings. Pests such as cutworms, armyworms, vegetable weevils, and slugs may hide in these sites, migrate into the greenhouse, and damage tobacco seedlings.
- If greenhouses are used to produce other crops, a fallow period should be followed to keep pests from moving from the other crops. Whiteflies or aphids may become problems moving from earlier crops to tobacco.
- 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.
- Seed the entire greenhouse at the same time. Do not seed tobacco in greenhouses that are already infested with large numbers of shore flies. Shore flies lay eggs on the media and the larvae injure emerging seedlings reducing stand and seedling uniformity

- Clean the greenhouse thoroughly just before seeding in the spring.
- Produce a uniform crop.

<u>Chemical control in the greenhouse</u>

Acephate (Orthene or other 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 the float water. Acephate also gives effective control of ants when applied in the greenhouse before the float beds are set up. When spraying young plants, use the proper rate. Excessive rates of acephate can injure or kill young seedlings.

Metaldehyde (Deadline Bullets) bait controls 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 methaldehyde directly to seedlings or use it in float beds.

Mice should be controlled with baits labeled for their control.

Table 1. Insecticides for use on Transplants Grown in Greenhouses

<table>
<tr><th>Insect</th><th>Insecticide and formulation</th><th>Rate per 1,000 sq ft</th></tr>
<tr><td>Aphids, cutworms, flea beetles</td><td>Acephate (Acephate AG) 75SP
(Acephate) 97UP
(Orthene) 97PE</td><td>1 tbs/3 gal of water (1 lb/acre)
¾ tbs/3 gal of water (¾ lb/acre)
¾ tbs/3 gal of water (¾ lb/acre)</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td>Snails and slugs</td><td>Metaldehyde (Deadline Bullets) 4% bait</td><td>¼ to ½ lb</td></tr>
<tr><td colspan="3">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. It is deactivated by water.</td></tr>
<tr><td>Ants</td><td>Acephate (Acephate AG) 75SP
(Acephate) 97UP
(Orthene) 97PE</td><td>1 oz/5 gal of water
¾ oz/5 gal of water
¾ oz/5 gal of water</td></tr>
<tr><td colspan="3">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.</td></tr>
</table>

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 occurs 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 as soil, tray drench or transplant water treatments for wireworm control (Table 2). Apply soil insecticides (Lorsban or Mocap) as broadcast treatments and incorporate them at least 2 weeks before transplanting. Another option is to use Admire Pro, Platinum, or their generics applied at the wireworm rates as transplant water or transplant drench treatments. The most effective cultural practice for wireworm control 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 although crop maturity may be delayed. If wireworms seriously reduce the stand, replant after a recommended soil insecticide is applied.

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 but it may affect uniformity. Cutworm infestations are very sporadic and difficult to predict, but they are most likely to occur in low, wet areas, and 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 10). 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.

Whitefringed beetles

Whitefringed beetle grubs sometimes cause serious problems in flue-cured and burley tobacco fields. Outbreaks usually occur in fields rotated with clover, soybeans, or alfalfa. Most legumes are excellent food plants for the grubs, while most grasses are unfavorable hosts. Grubs feed on the outer surface of the taproots and tunnel into the pith of newly transplanted tobacco killing or stunting the plants and causing serious yield reductions. Whitefringed beetles spread very slowly because all adult beetles are flightless female weevils. They can be transported to a new field, on farm equipment, water, hay, and other crops. No insecticides are currently registered for the control of whitefringed beetles on tobacco. The rotation of tobacco with good stands of grass containing few legumes or broadleaf weeds may help reduce grub damage. Imidacloprid (Admire and generics) and thiamethoxam (Platinum and TMOXX) provide some control of whitefringed beetles.

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.
- Mocap, Brigade/Capture, and Lorsban are broadcast soil treatments for wireworm control (Tables 2 and 3).
- Admire Pro or Platinum applied as transplant water or transplant drench treatments may be better choices for wireworm control because they also control aphids and flea beetles (Tables 2, 4, and 5).
- Soil fumigants applied at the nematicide rate provide little control of insects in the soil or on the foliage 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: Aphids	Leaf feeding insects: Bud-worms	Leaf feeding insects: Flea beetles	Soil insects: Horn-worms	Soil insects: Cut-worms	Soil insects: Wire-worms
Acephate/Acephate AG/ Acephate UP; Orthene 97	TW	2	0	2	0	3-4	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
Chlorpyrifos (Lorsban) 4E	PPI	0	0	1	0	3	4
Chlorantraniliprole (Coragen)	TPW	0	2	0	3	0	0
Lambda cyhalothrin (Karate, Warrior and others)	PPI	0	0	0	0	3	0
Ethoprop (Mocap) 6EC	PPI	0	0	1	0	3	4
Thiamethoxam (Platinum/TMOXX) 2F	TW	5	0	3	0	0	3
Thiamethoxam (Platinum/TMOXX) 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, Cutworms	Ethoprop	$1\ ^1/_3$ to
	(Mocap) 6EC	4 qt
	(Mocap) 15G	13 lb
	Chlorpyrifos (Lorsban) 15G	13 ½ lb
	(Lorsban and generics) 4E	1 qt
	Lorsban Advance 3.755EW	1 qt
	Bifenthrin (Brigade/Capture and generics) 2EC	2.56 to 6.4 fl oz
	Lambda cyhalothrin (Karate with Zeon and generics) 2.1EC	1.92 fl oz

Remarks and precautions: Make broadcast applications at least 2 weeks before transplanting. Band applications are usually less effective than broadcast treatments. Use a suitable device to incorporate insecticides into the soil to a depth of at least 4 inches immediately after application. Chlorpyrifos and bifenthrin are also registered for cutworms and flea beetle larvae. **These chemicals are restricted use.**

Table 4. 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
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/TMOXX) 2SC	0.5 to 0.8 fl oz/1,000 plants or (3 to 5 fl oz/acre)
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 or poor performance will result.		
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/TMOXX) 2SC	0.8 to 1.3 fl oz/1,000 plants or (5 to 8 fl oz/acre)
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.**		

Table 5. 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
	(TMOXX) 2SC	0.5 to 0.8 fl oz
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
	(TMOXX) 2SC	0.6 to 1.3 fl 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.

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. Sample in a Z or N pattern across 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). Make counts and record 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. Sample an additional 10 plants for every two additional acres in fields larger than 10 acres.
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 the budworm parasite, *Campoletis sonorensis.* If there is budworm damage, but no worm, do not count the plant as infested.

b. Examine the entire plant for hornworm damage, locate, count the hornworms that are at least 1 inch long, and determine whether they are parasitized by *Cotesia congregate* (white egg-like cocoons on hornworm's back).

c. 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 the mines of the tobacco splitworm.

d. If you find an unidentified insect that appears to be damaging the crop, collect the insect and samples of its damage, put them in a container, and take them to a local Extension agent for identification. This is important because beneficial insects are often mistaken for pests. In addition, 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	10 plants with one or more budworm 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 2 weeks old, 8 to 10 beetles per plant on 2 to 4 week-old plants, 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. Do not count parasitized worms with the egg-like cocoons on their backs. For hornworms ½ to ¾ inch long, treat when there is 1 hornworm per plant.	3 weeks after transplanting to final harvest. Can be a problem on air-cured tobacco in curing structures
Wireworms	Not determined	1 to 6 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. Control with foliar sprays rarely exceeds 80%. The tobacco rows must be planted evenly so that the nozzles can be oriented directly over the 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 the wasp (*Campoletis*) that parasitizes budworms. These cocoons are about ¼ inch long and white or grayish in color with two black bands or dots. *Campoletis* and other 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, but damage is usually most severe during June, August, and September. Treat for hornworms when there are 5 or more hornworms 1 inch long or longer per 50 plants. Do not count parasitized hornworms that have the white egg-like cocoons of the parasitic wasp, *Cotesia congregata*, on their backs. Parasitized hornworms eat much less than healthy hornworms and they are a food source for parasites that help reduce the next generation of hornworms. Predators also kill large numbers of 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 control of hornworms, direct insecticide sprays to the upper one-half of the plants. See the 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 fertilization with 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. Aphid populations increase rapidly, doubling in size about every two days under favorable conditions. High populations of aphids can reduce tobacco yield by 5 to 25 % (100 to 500 lbs/acre) or more. As aphids feed, they excrete honeydew that contains the excess sugars obtained from the plant sap. This sticky, shiny honeydew and tiny white exoskeletons are deposited on the leaves below the feeding aphids. A dark, sooty mold often grows on the honeydew. 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 from late June to September. Tobacco plants become infested when winged aphids fly into fields and deposit young wingless nymphs on the upper leaves. It is important to 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**

   a. **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.

   b. **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 modes of action reduces the chances that resistance will develop. The insecticides available for aphid control on tobacco are in several different groups based on their modes of action (the way they kill aphids) (Table 9). When applying several insecticides for aphid control over the growing season, change from one group 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) because they are in different chemical groups.

   c. **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, or other factors contributed to the poor control. If the aphids appear to be resistant, apply an insecticide in another group (Table 9).

   d. **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 concentrated on the undersides of the leaves. Drop nozzles improve control if aphids are abundant on the undersides of the lower leaves.

   e. **Continue to scout the crop** after satisfactory control is obtained. Aphid populations 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:

a. **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.

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

c. **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.

d. **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.

e. **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 Beetle

Adult tobacco flea beetles feed on the leaves and stalks of tobacco, while the grubs or larvae 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 beetles on 20 plants (2 per field-sample location). **Apply treatments for flea beetles on newly set tobacco when there are 4 or more beetles per plant**. Larger plants can tolerate very high flea beetle densities. Apply an insecticide when the base of the lower leaves have a netted appearance or densities exceed 60 beetles per plant. 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 flea beetle populations and the resulting damage the next year. Tobacco with nitrogen deficiency 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 are emerging from the soil over an extended period.

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 occurred at very low rates 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, Belt, Denim, Tracer, and acephate applied in high volumes of water provide fair to good control. Denim was the most effective treatment for splitworms in one trial. Early-season applications of Karate/Warrior appear to be effective but are rarely necessary and no early-season thresholds have been established.

It is important to avoid planting or storing Irish potatoes near tobacco fields because they are an important source of this pest in tobacco. If splitworm mines are observed on the lower leaves, the leaves should be harvested and cured as soon as possible. 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.

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 insect pests on flue-cured tobacco.

Insecticide	Aphid	BW[1]	CW[1]	FB[1]	G[1]	HW[1]
Actara/TMOXX	4	0	0	4	0	0
Assail	4	2	0	4	0	3*
Bacillus thuringiensis	0	2	0	0	0	5
Agree, Crymax/Dipel/Javelin/ Lepinox/XenTari						
Belt	0	4	0	0	0	5
Brigade/Capture	3	3	4	3	3	5
Coragen	0	4	0	0	0	5
Denim	0	4	0	0	0	4
Fulfill	3	0	0	0	0	0
Lannate	2	3	0	2	0	5
Orthene/Acephate/ Acephate 97UP	4	3	4	2	4	5
Provado/Nuprid	4	0	0	2	0	0
Tracer	0	4	0	0	0	4
Karate/Warrior	1	3	3	3	3	5

[1] BW = Budworm; CW = Cutworm; FB = Flea Beetle; G = 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.

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

Insecticide	Restricted entry Intervals (REI) (hours)	Preharvest interval (PHI) (days)
Foliar treatments		
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
Flubendiamide (Belt)	14	14
Imidacloprid (Nuprid/Provado) 1.6F	12	14
Lambda-cyhalothrin (Karate/Warrior 1CS)	24	40
Methomyl (Lannate)	48	7
Pymethozine (Fulfill)	12	14
Spinosad (Tracer)	4	3
Thiamethoxam (Actara/TMOXX))	12	14
Soil treatments		
Bifenthrin (Brigade/Capture)	12	Do not apply after layby
Chlorpyrifos (Lorsban/Lorsban Advance)	24	"
Ethoprop (Mocap)	48	"
Metaldehyde (Deadline Bullets)	12	"
Greenhouse seedling drench or transplant water treatments		
Acephate (Orthene/Acephate)	24	3
Bifenthrin (Brigade/Capture)	12	Do not apply after layby
Chlorantraniliprole (Coragen)	4	1
Imidacloprid (Admire Pro and various generics)	12	14
Lambda-cyhalothrin (Warrior/Karate)	12	40
Thiamethoxam (Platinum/TMOXX) 2F	12	14

Minimizing Insecticide Residues

Pesticide residues are an important factor in the quality of cured tobacco that can cause some contractors to reject a tobacco 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 endosulfan (Cekulfan, Ednosulfan, Emusifiable Concentrate, Thiodan, Thiokill, Golden Leaf Tobacco Spray).** There are several insecticides that give equal or superior control. Some companies specify in their contacts that this chemical must not be used on the tobacco.
- **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.
- **Use insecticides with short preharvest intervals during the harvest period.** *Bt* and Tracer are good options for hornworms, Orthene provides effective control of aphids and some control of flea beetles, but there is usually no need for late-season applications.

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 in the same mode of action group to control an insect more than once during the growing season. This reduces the chances that an insect will develop resistance to the insecticides registered for tobacco.

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

Goup #	Mode of action	Chemical sub-group or active ingredient	Product name
1A	Acetylcholine esterase inhibitors	Carbamates	Lannate
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	Tracer
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.
28	Ryanodine receptor inhibitor	Chlorantraniliprole Flubendiamide	Belt, Coragen

Table 10. Insects on Field Tobacco - Foliar Treatments

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 heavy. 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.	
	Acetamiprid (Assail) 70WP	0.6 to 1.7 oz
	(Assail) 30WG	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 Admire Pro, Platinum, Provado, or Actara. Also provides fair control of hornworms.	
	Bifenthrin (Brigade/Capture) 2EC	2.56 to 6.4 fl oz
	Remarks and precautions: MOA = 4. **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, Provado, or TMOXX.**	
	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, TMOXX, Admire Pro, Assail, or Provado. Apply only once during the growing season.	

Table 10. Insects on Field Tobacco - Foliar Treatments (Cont'd)

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. Apply as a spray. When using hand sprayer apply in 10 to 50 gal/acre.	
	Bacillus thuringiensis	
	(Agree) WG	1 to 2 lb
	(Crymax) WG	½ to 2 lb
	(Dipel) DF	½ to 1 lb
	(Dipel) ES	1 to 2 pt
	(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**.	
	Bifenthrin ((Brigade/Capture) 2EC	4.0 to 6.4 fl oz
	Remarks and precautions: MOA = 3. **Restricted use.** Do not apply after layby.	
	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 with applications.	

Table 10. Insects on Field Tobacco - Foliar Treatments (Cont'd)

Insect	Insecticide and formulation	Rate per acre
Budworms (cont'd)	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.	
	Flubendiamide (Belt) 4SC	2 to 3 fl oz
	Remarks and precautions: MOA = 28. Apply in at least 10 gal/acre. Do not exceed four applications per year.	
	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 as indicated by field scouting. Observe the 40-day preharvest interval.	
	Methomyl (Lannate) 90SP	½ lb
	(Lannate) 2.4LV	1 ½ pt
	Remarks and precautions: MOA = 1A. **Restricted Use.** Apply as a spray. Make applications as needed. Direct the spray into the buds before buttoning.	
	Spinosad (Tracer) 4F	1½ to 2 fl oz
	(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.	
Cut-worms	Acephate (Acephate AG) 75SP	1 lb
	(Acephate) 97UP	¾ lb
	(Orthene) 97PE	¾ lb
	Remarks and precautions: MOA = 5. 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.	
	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.	

Table 10. Insects on Field Tobacco - Foliar Treatments (Cont'd)

Insect	Insecticide and formulation	Rate per acre
Flea beetles	Acephate (Acephate AG) 75SP (Acephate) 97UP (Orthene) 97PE	$^2/_3$ lb ½ lb ½ lb
	Remarks and precautions: MOA = 1B. Apply as a spray. Prime before treating	
	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
	Remarks and precautions: MOA = 4. Apply as spray. **Do not apply to tobacco already treated with imidacloprid, acetimiprid, or thiamethoxam.**	
	Lambda-cyhalothrin Karate (Warrior) 1CS (Karate with Zion, Warrior II) 2.1SC	 1.9 to 3.8 fl oz 0.96 to 1.92 fl oz
	Remarks and precautions: MOA = 4. **Restricted Use**. Apply in sufficient water for coverage.	
	Methomyl (Lannate) 90SP (Lannate) 2.4LV	¼ to ½ lb 1 ½ pt
	Remarks and precautions: MOA = 1A. **Restricted Use.** Apply as a spray.	
	Thiamethoxam (Actara) 25WDG	2 to 4 oz
	Remarks and precautions: MOA = 4**.** Do not apply to tobacco already treated with Admire Pro, Assail, Platinum, Provado, or TMOXX. Apply only once during the growing season.	
Grass-hoppers	Acephate (Acephate AG) 75SP (Acephate) 97UP (Orthene) 97PE Bifenthrin (Brigade/Capture) 2EC	$^1/_3$ to $^2/_3$ lb ¼ to ½ lb ¼ to ½ lb 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.	
	Lambda-cyhalothrin (Warrior) 1CS (Karate with Zion, Warrior II) 2.1SC	1.9 to 3.8 fl oz 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.	

Table 10. Insects on Field Tobacco - Foliar Treatments (Cont'd)

Insect	Insecticide and formulation	Rate per acre
Hornworms	Acephate (Acephate AG) 75SP (Acephate) 97UP (Orthene) 97PE	$^{2}/_{3}$ lb in water ½ lb 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.	
	Bacillus thuringiensis (Agree) WG (Crymax) WG (Dipel) DF (Dipel) ES (Javelin) WG	 1 to 2 lb ½ to 2 lb ¼ to 1 lb ½ to 1 pt $^{1}/_{8}$ 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.	
	Emamectin benzoate (Denim) 0.16EC	8 to 12 fl oz
	Remarks and precautions: MOA = 9. **Restricted Use**. Apply in sufficient water for through coverage before damaging infestations occur.	
	Flubendiamide (Belt) 4SC	2 to 3 fl oz
	Remarks and precautions: MOA = 28. Apply in at least 10 gal/acre. Do not exceed four applications per year.	
	Emamectin benzoate (Denim) 0.16EC	8 to 12 fl oz
	Remarks and precautions: MOA = 9. **Restricted Use**. Apply in sufficient water for through coverage before damaging infestations occur.	

Table 10. Insects on Field Tobacco - Foliar Treatments (Cont'd)

Insect	Insecticide and formulation	Rate per acre
Hornworms cont'd	Lambda-cyhalothrin (Warrior) 1EC (Karate with Zion, Warrior II) 2.1SC	1.9-3.8 fl oz 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.	
	Methomyl (Lannate) 90SP (Lannate) 2.4LV	¼ to ½ lb ¾ to 1 ½ pt
	Remarks and precautions: MOA = 1A. **Restricted Use.** Apply as a spray.	
	Spinosad (Tracer) 4F Blackhawk 36WG	1 to 2 fl oz 1.6 to 3.2 oz
	Remarks and precautions: MOA = 5. Apply as a spray in at least 20 gal of water per acre.	
Japanese beetles	Acephate (Acephate AG) 75SP (Acephate) 97UP (Orthene) 97PE	$^{2}/_{3}$ to 1 lb ½ to ¾ lb ½ to ¾ lb
	Remarks and precautions: MOA = 1B. Apply as a spray in 10 to 50 gal/acre. Prime before treating.	
	Bifenthrin (Brigade/Capture) 2EC	4.0 to 6.4 fl oz
	Remarks and precautions: MOA = 4. **Restricted use.** Do not apply after layby.	
	Imidacloprid (Provado) 1.6F Thiamethoxam (Actara) 25WDG	4 fl oz 3 oz
	Remarks and precautions: MOA = 4. Apply as a spray. Damage is usually less severe than it appears.	
	Lambda-cyhalothrin (Warrior) 1EC (Karate with Zion, Warrior II) 2.1SC	1.9 to 3.8 fl oz 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 10. Insects on Field Tobacco - Foliar Treatments (Cont'd)

Insect	Insecticide and formulation	Rate per acre
Slugs	Metaldehyde (Dealine Bullets) 4 % Bait	12 to 40 lb
	Remarks and precautions: Apply as a broadcast treatment to the soil surface in the late evening. Metaldehyde is most effective after irrigation or a rain.	
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.	
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.	

Table 10. Insects on Field Tobacco - Foliar Treatments (Cont'd)

Insect	Insecticide and formulation	Rate per acre
Thrips	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 (Karate with Zion, Warrior II) 2.1SC	 1.9 to 3.8 fl oz 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.	

CURING TOBACCO

T. David Reed, Extension Agronomist, Tobacco

Flue-Cured Tobacco Curing

Curing flue-cured tobacco should be considered a complex procedure because of differences in type of tobacco (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.

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.

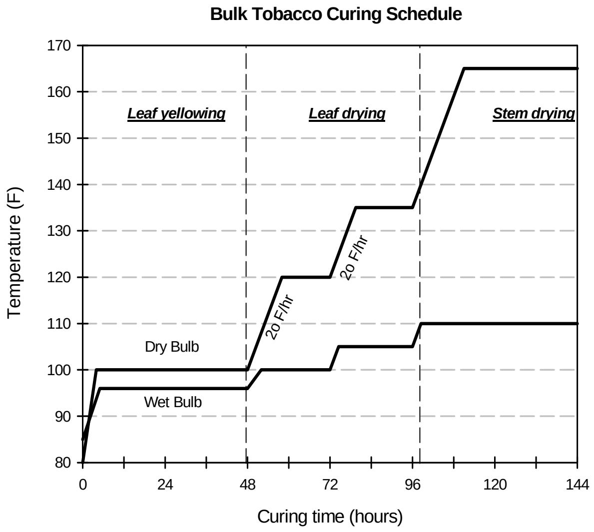
2. Yellowing - Start heat at outside temperature and advance temperature 2°F per hour to 100°F. It may be necessary to open vents slightly during yellowing, but care must be taken to avoid setting green color by lowering relative humidity too much or drying too fast.

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 tobacco is used in the curing process. The following energy efficient curing practices should be followed to help reduce the cost of curing.

1. Use 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.
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. Tune up the fuel burner; 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 considered to be a group of the most potent carcinogens found 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 involves nitrous oxides (NOx) produced as a by-product of combustion of LP or fuel oil with alkaloids present in the tobacco. The use of indirect-fired heating, where a heat exchanger removes the combustion gases from the barn, has been found to reduce TSNA when compared to direct-fired curing barns.

In 1999, the Tobacco Industry Leadership Group proposed the retrofitting of all direct-fired bulk curing barns to indirect-fired heating. This became a requirement for full grade loan rate (price support) the following season and is currently required by contract purchasers. More than 30,000 barns were retrofitted across the flue-cured tobacco belts with some of the expense reimbursed by an industry supported cost share program. Over the brief period of time since the barn retrofit program was implemented, the industry has recognized that maintenance and testing of heat exchangers will be an ongoing process to ensure that leaks do not occur and NOx does not cause TSNA levels to increase. For the 2003 growing season, the Tobacco Industry Leadership Group has provided funding to tobacco extension programs in all tobacco producing states to conduct education programs to introduce the need for heat exchanger testing. In Virginia, county extension agents have access to CO_2 meters for barn testing and will visit barns at grower's request. This program is not intended to provide any form of barn certification and results of barn testing are reported only to the grower.

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^{o}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

T. David Reed
Extension Agronomist, Tobacco

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.

<u>1/128th of an acre Calibration Procedure</u>

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 $1/128^{th}$ 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.

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.)	42	44	46	48
16	9334	8910	8523	8168
17	8785	8386	8021	7687
18	8297	7920	7576	7260
19	7860	7503	7177	6878
20	7467	7128	6818	6534
21	7112	6789	6493	6223
22	6789	6480	6198	5940
23	6493	6198	5929	5682
24	6223	5940	5682	5445
25	5974	5702	5454	5227
26	5744	5483	5245	5026
27	5531	5280	5050	4840
28	5334	5091	4870	4667
29	5150	4916	4702	4506
30	4978	4752	4545	4356

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.

TOBACCO FARM WORKER SAFETY

T. David Reed, Extension Agronomist, Tobacco

Tobacco is a labor intensive crop with many situations that may expose workers to potential hazards. These hazards include ones common to other farming operations such as tractors and machinery, pesticides, and laboring in hot weather. Green tobacco sickness or GTS is a potential hazard specific to working in tobacco.

Workers should be properly trained in the safe operation of tractors and other machinery. Situations that may result in a rollover accident should be avoided. Tractor operators must be especially careful when traveling on highways as motorists often fail to appreciate the slow speed and size of farm equipment on the highway. The handling of bulk curing boxes around barns is an especially hazardous situation. Tobacco balers also represent a unique hazard with multiple pinch points and the risk of severe injury. Workers should not be allowed to get into balers when making bales.

All tobacco producers should be licensed pesticide applicators and therefore be able to provide proper supervision of workers that may be making pesticide applications or be in the vicinity of such applications. A central notification area should be available to notify workers of any pesticide applications and applicable restricted entry intervals following an application. Material safety data sheets (MSDS) should be made available for products used on the farm. The pesticide label will provide information on notification and posting requirements, restricted entry interval (REI), and any requirements for personal protective equipment (PPE). The PPE may different for workers handling the materials, or applying the material, or re-entering the field during the REI.

Green tobacco sickness (GTS) is a condition specific to working in tobacco fields. The condition results from the absorption of nicotine through the skin. Absorption of nicotine is most likely to occur when the tobacco is wet. Nicotine levels in the plant are naturally highest during harvest season, less so at topping, and much less earlier in the season; thus potential exposure is greatest during the harvest season.

Symptoms of GTS may include:

- Headache
- Dizziness
- Nausea
- Vomiting
- Insomnia
- Loss of appetite

Although GTS is not usually a dangerous condition, the risk of dehydration is possible if an affected worker is unable to eat or drink.

Ways to Avoid Green Tobacco Sickness

- Wear a long sleeve shirt to reduce direct contact with tobacco leaves.
- Change into dry clothing if work clothes get wet from contact with tobacco.
- Wear clean work clothing each day to avoid exposure to nicotine that may accumulate each day.
- When it is necessary to work in wet tobacco, wear a protective rain suit.

EPA Worker Protection Standards for Commonly Used Pesticides for Flue-Cured Tobacco 2011

Charles S. Johnson, Extension Pathologist, Tobacco
Paul J. Semtner, Extension Entomologist, Tobacco
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**	**Personal Protective Equipment (PPE)[2] To Enter Treated Area Within REI[3]**	**Worker Notification[4] Oral**	**Worker Notification[4] Posted**
Acephate ® 75SP AG (acephate) EPA Reg. No. 51036-236 Micro Flo **Acephate 97UP** EPA Reg. No. 70506-8 United Phosphorus	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 25 WDG (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
Acrobat 50WP (dimethomorph) EPA Reg. No. 241-410 BASF Corporation	Caution	12 hr	long-sleeved shirt and long pants; chemical resistant gloves made of any waterproof material, such as polyethylene or polyvinyl chloride; shoes plus socks	coveralls; chemical resistant gloves made of any waterproof material, such as polyethylene or polyvinyl chloride; shoes plus socks	either	either
Admire® Pro 4.6SC (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
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
Agri-Mycin 17 (streptomycin sulfate) EPA Reg. No. 55146-96 Nufarm Americas Inc.	Caution	12 hr	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
Aim EC (carfentrazone) EPA Reg. No. 279-3241 FMC Corporation **Aim EW** (carfentrazone) EPA Reg. No. 279-3242 FMC Corporation	Caution	12 hr	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either
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. 264-758-66222 Makhteshim Agan of North America, 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

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
Assail ® 70WP (acetamiprid) EPA Reg. No. 8033-23-4581 Cerexagri, Inc. **Assail ® 30WG** EPA Reg. No. 8033-36-82695	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
Belt (flubendiamide) EPA Reg. No. 264-1025 Bayer CropScience	Caution	12 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves (such as natural rubber); shoes plus socks	coveralls, chemical-resistant gloves such as Barrier Laminate, Butyl rubber, Nitrile rubber, or Viton, 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
Brigade 2EC (bifenthrin) EPA Reg. No. 279-3313 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
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

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
Brom-O-Gas® (98% methyl bromide) EPA Reg. No. 5785-4, -42 Great Lakes Chemical	Danger	48 hrs. and gas concentration less than 5 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 (NO GOGGLES); fullface respirator required when air concentration exceeds 5ppm	non-handlers prohibited	yes	yes
Capture 2EC (bifenthrin) EPA Reg. No. 279-3114 FMC Corporation Capture LFR 1.5EC EPA Reg. No. 279-3302	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
Chlor-O-Pic® (99% chloropicrin) EPA Reg. No. 5785-17 Great Lakes Chemical **Chloropicrin 100®** EPA Reg. No. 8536-02-8853 Hendrix and Dail, Inc.	Danger	48 hrs. and gas concentration 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]		Worker Notification[4]	
			Applicators and Other Handlers	To Enter Treated Area Within REI[3]	Oral	Posted
Command ® 3ME EPA Reg. No. 279-3158 FMC Corporation EPA Reg. No. 279-3158-5905 Helena Chemical Co. EPA Reg. No. 279-315-34704 UAP-Loveland Products, Inc. EPA Reg. No. 279-3158-55467 Tenkoz, Inc.	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
Deadline Bullets 4G **(**metaldehyde) EPA No. 64864-00002-AA-00000 Pace International	Caution	12 hrs.	long-sleeved shirt and long pants; shoes plus socks	long-sleeved shirt; 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
Denim 0.16EC (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-EC (napropamide) EPA Reg. No. 70506-64 United Phosphorus, Inc.	Danger	12 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves such as Barrier Laminate or Viton ≥ 14 mils; shoes plus socks; protective eyewear	coveralls; chemical-resistant gloves such as Barrier Laminate or Viton ≥ 14 mils; shoes plus socks; protective eyewear	either	either
Devrinol® 50-DF (napropamide) EPA Reg. No. 70506-36 United Phosphorus, Inc.	Caution	12 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves, shoes plus socks	coveralls; chemical-resistant gloves; shoes plus socks	either	either
Dipel® DF (*Bacillus thuringiensis*) EPA Reg. No. 275-103 Valent **Dipel® ES** EPA Reg. No. 73049-17	Caution	4 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either
Dithane® DF Rainshield (mancozeb) EPA Reg. No. 62419-402 SLN No. VA940001 Dow AgroSciences LLC	Caution	24 hrs.	coveralls over long-sleeved shirt and long pants; chemical resistant gloves; shoes plus socks	coveralls over 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
Drexalin Plus (flumetralin) EPA Reg. No. 19713-2-510 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
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
Firewall (streptomycin sulfate) EPA Reg. No. 80990-4-82695 United Phosphorus Inc. **Fire Wall 17 WP (streptomycin sulfate) EPA Reg. No. 80990-4 AgroSource Inc.**	Caution	12 hr	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

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
FluPro (flumetralin) EPA Reg. No. 73631-2-400 Uniroyal	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 Corporation	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
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. 100-192 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
Lannate® L (methomyl) EPA Reg. No. 352-370 **Lannate® LV** EPA Reg. No. 352-384 DuPont	Danger	48 hrs.	long-sleeved shirts and long legged pants; chemical-resistant gloves; shoes plus socks; protective eyewear; exposure outdoors mist/dust filtering respirator	coveralls; chemical-resistant gloves; shoes plus socks, protective eyewear	either	either
Lannate® SP (methomyl) EPA Reg. No. 352-342 DuPont	Danger	48 hrs.	long-sleeved shirts and long legged pants; waterproof gloves; shoes plus socks; protective eyewear; exposure outdoors mist/dust filtering respirator (MSHA/NIOSH approval no. prefix TC-21C)	coveralls; waterproof gloves; shoes plus socks, protective eyewear	either	either
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

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
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
Manzate Pro-Stick (mancozeb) EPA Reg. No. 352-704 SLN No. VA-080004 DuPont Crop Protection	Caution	24 hrs.	coveralls over long-sleeved shirt and long pants; chemical resistant gloves; shoes plus socks	coveralls over long-sleeved shirt and long pants; chemical resistant gloves; shoes plus socks	either	either
MetaStar 2E AG (metalaxyl) EPA Reg. 71532-5-66330 Arysta LifeScience North America Corp.	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
Nuprid 2F (imidacloprid) EPA Reg. No. 228-484 Nufarm Americas, Inc **Nuprid 1.6F** EPA Reg. No. 228-488	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® (C6 - C12 fatty alcohols) EPA Reg. No. 57582-3 Cochran	Warning	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

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. 59639-91 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. 264-763-6622 Makhteshim Agan of North America, Inc	Caution	12 hrs.	long-sleeved shirt and long pants, waterproof gloves; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either
Penncozeb 75DF (mancozeb) EPA Reg. No. 70506-185 SLN No. VA-080005 United Phosphorus, Inc	Caution	24 hrs.	coveralls over long-sleeved shirt and long pants; chemical resistant gloves; shoes plus socks	coveralls over long-sleeved shirt and long pants; chemical resistant gloves; shoes plus socks	either	either
Pic Plus (chloropicrin) EPA Reg. No. 8853-6 Hendrix and Dail, Inc.	Danger	48 hrs. and gas concentrat-ion 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 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	Personal Protective Equipment (PPE)[2] To Enter Treated Area Within REI[3]	Worker Notification[4] Oral	Worker Notification[4] Posted
Poast® (sethoxydim) EPA Reg. No. 7969-58-51036 SLN No. VA-980004 Micro Flo Co., LLC	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
Prep® (ethephon) EPA Reg. No. 264-418 Bayer CropScience	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
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

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
Provado 1.6F ® (imidacloprid) EPA Reg. No. 3125-457 Bayer CropScience	Caution	12 hrs.	long-sleeved shirt and long pants, waterproof gloves; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either
Prowl® 3.3 (pendimethalin) EPA Reg. No. 241-337 BASF Corp. **Prowl® H_20** (pendimethalin) EPA Reg. No. 241-418 BASF Corp. **Pendimax 3.3** EPA Reg. No. 68156-6-62719 Dow AgroSciences LLC	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
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
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

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
Royal MH-30® (maleic hydrazide) EPA Reg. No. 400-84 Uniroyal Chemical	Caution	12 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks	coveralls; waterproof 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
Sucker Plucker® (C6 - C12 fatty alcohols) EPA Reg. No. 19713-35 Drexel	Warning	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

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 Stuff® (maleic hydrazide) EPA Reg. No. 19713- **Super Sucker Stuff®** EPA Reg. No. 19713-20 Drexel	Caution	12 hrs.	long-sleeved shirt and long pants; shoes plus socks; waterproof gloves	coveralls; waterproof gloves; shoes plus socks	either	either
Telone® C-17 (1,3-Dichloropropene and Chloropicrin) EPA Reg. No. 62719-12 Dow AgroSciences LLC	Danger	5 days	**see label for extensively detailed instructions for PPE**	Non-handlers prohibited; **see label for extensive instructions for handlers**	yes	yes
Telone® II (1,3-Dichloropropene) EPA Reg. No. 62719-32 Dow AgroSciences LLC	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 Chemtura USA Corporation	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
Tracer® 4 (spinosad) EPA Reg. No. 62719-267 SLN No. VA980001 Dow AgroSciences	Caution	4 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
Ultra Flourish (mefenoxam) EPA Reg. No. 55146-73 NuFarm Americas, Inc.	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 **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

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
Warrior (lambda-cyhalothrin) EPA Reg. No. 100-1112 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® WDG (*Bacillus thuringiensis)* EPA Reg. No. 275-85 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."

COMMONWEALTH of VIRGINIA

VIRGINIA BRIGHT FLUE-CURED TOBACCO BOARD

P. O. Box 129
Halifax, Virginia 24558

ANNUAL REPORT

JULY 1, 2010- JUNE 30, 2011

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 BOARD: The Virginia Flue-cured Tobacco Board is composed of seven tobacco producers appointed by the Governor, who is guided in his appointments by recommendations of organizations representing flue-cured tobacco producers. The members represent legislatively-defined flue-cured tobacco producing areas in Virginia.

FUNDING: Board program funding originates from an excise tax paid by all flue-cured tobacco producers. The excise tax levy is 20 cents per hundred pounds of tobacco sold. The excise tax levied is collected by company receiving stations at the time the tobacco is sold by producers and is subsequently remitted to the Board. The Board is responsible for ensuring that the tax has been properly collected and remitted.

BOARD PROGRAMS:

I. Market Development and Promotion:

The Board, by contractual agreement, provided $46,000 to Tobacco Associates, Inc. to be used in market development and promotion 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 is funded through producer assessments in all flue-cured tobacco producing states (in Virginia's case by virtue of the appropriation by the Board). Tobacco Associates is governed by a producer-controlled board of directors of which two members are from Virginia.

On behalf of U. S. growers, Tobacco Associates conducted U. S. leaf utilization programs and leaf grading seminars in selected countries, hosted foreign customers and prospective clients, participated in trade fairs and exhibits worldwide and informed producers and farm organizations concerning pertinent international tobacco market developments.

II. Research

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

III. Education

The Board provided funding for the printing of the annual Flue-cured Tobacco Production Guide, which was prepared and distributed to producers by the Virginia Cooperative Extension Service. This publication provides current information to producers on all aspects of flue-cured tobacco production.

FINANCIAL STATEMENT

July 1, 2010 - June 30, 2011

Revenue:		
Cash Balance - July 1, 2010	$ 38,687.46	
Excise Tax Receipts	79,547.15	
Interest Earned	614.19	
Total		$ 118,848.80
Expenditures:		
Administration	$ 817.23	
Market Development and Promotion	46,000.00	
Research	29,483.61	
Education	1,483.95	
Total		$ 77,781.26
Cash Balance - June 30, 2011		$ 41,067.54

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This information is being provided in accordance with legislation passed in the 1990 Virginia General Assembly requiring that each commodity board provide an annual report to its excise-tax paying producers.