2013 Georgia Tobacco Grower's Guide

Cooperative Extension - The University of Georgia
College of Agricultural and Environmental Sciences
in cooperation with Georgia Tobacco Commission

The 2013 Georgia Tobacco Grower's Guide is intended to help Georgia Farmers deal with problems encountered in growing tobacco. If an unknown problem is seen in a field, call or FAX your local County Extension Agent. County Agents receive periodic updates on tobacco culture and all county Extension offices contain pictures and descriptions of tobacco ailments useful for identification. If the problem cannot be identified in the county, all county agents are supported by a team of specialists and plant diagnostic clinics.

EXTENSION OFFICES IN COUNTIES WITH TOBACCO PRODUCTION

County	Phone No.	FAX No.	County	Phone No.	FAX No.
Appling	912-367-8130	912-367-1184	Jeff Davis	912-375-6648	912-379-1091
Atkinson	912-422-3277	912-422-6223	Lanier	229-482-3895	229-482-2654
Bacon	912-632-5601	912-632-6910	Lowndes	229-333-5185	229-333-5188
Ben Hill	229-426-5175	229-426-5176	Pierce	912-449-2034	912-449-8005
Berrien	229-686-5431	229-686-7831	Tattnall	912-557-6724	912-557-3332
Brantley	912-462-5724	912-462-5464	Telfair	912-868-6489	912-868-2773
Brooks	229-263-4103	229-263-5607	Thomas	229-225-4130	229-225-4183
Candler	912-685-2408	912-685-6614	Tift	229-391-7980	229-391-7999
Coffee	912-384-1402	912-389-4007	Toombs	912-526-3101	912-526-1012
Colquitt	229-616-7455	229-616-7033	Treutlen	912-529-3766	912-529-3767
Cook	229-896-7456	229-896-7457	Ware	912-287-2456	912-287-2499
Echols	229-559-5562	229-559-9436	Wayne	912-427-5965	912-427-5967
Irwin	229-468-7409	229-468-9838	Worth	229-776-8216	229-776-8216

UGA Tobacco Home Page **http://www.georgiatobacco.com**

Prepared by:
J. Michael Moore, Extension Agronomist - Tobacco, Editor
Paul Bertrand, Extension Pathologist (Retired)
David Jones, Extension Entomologist (Retired)
William D. Givan, Extension Agricultural Economist (Retired)
Paul Sumner, Extension Engineer (Retired)
Glendon H. Harris, Extension Agronomist - Environmental Soil and Fertilizer
Keith D. Kightlinger, Extension Economist - Farm Management (Retired)
Glen C. Rains - Extension Engineer

Physical / Postal Address: UGA Tifton Campus / 2360 Rainwater Road, Tifton, Georgia, 31793

UGA Tobacco Home Page **http://www.georgiatobacco.com**

TABLE OF CONTENTS

(continues)

TABLE OF CONTENTS

(continues)

TABLE OF CONTENTS

(continues)

TABLE OF CONTENTS

(continues)

TABLE OF CONTENTS

(continues)

TABLE OF CONTENTS

(continues)

TABLE OF CONTENTS

GEORGIA TOBACCO OUTLOOK AND BUDGETS

William D. Givan and J. Michael Moore

In 2012, Georgia farmers experienced a good transplanting season with limited soil moisture. The remainder of the season continued to have limited rainfall for most of the production area. Georgia growers produced 9,600 acres in 2012, down from the acreage in 2011 and the smallest acreage in Georgia's history of tobacco production. However, the average yield of 2,360 pounds per acre was down from 2011, but better than for average of recent years. Georgia farmers once again produced the smallest tobacco crop in history. The number of growers continued to fall to approximately 150. Yields and quality continued to be improved over that of years prior to 2010. Following a warm January for this area growers observed one of the lowest levels of tomato spotted wilt incidence since the beginning of the Georgia epidemic. Costs of production continues to increase due to the price of fertilizer and the increasing cost of fuel for operating machinery and for curing tobacco.

Tomato spotted wilt virus (TSWV) losses amounting to approximately 10% yield loss and 22% of all plants showing symptoms resulting in another year of extremely low percentage of plants showing symptoms. The winter of 2011-2012 was relatively warm and based on recent work on a weather related model the tomato spotted wilt incidence was expected to be much greater than occurred. The crop was transplanted with low soil moisture, seasonal temperatures and over a three week period in April. Few plants were observed with TSWV symptoms until the crop was approaching the final cultivation. A high percentage of the crop continues to be treated with imidacloprid and Actigard as preventatives for control of TSWV. Race 1 black shank continues to rival TSWV as a major disease problem for Georgia tobacco production with a limited number of severely diseased crops during 2012.

Georgia tobacco producers continue to select a limited number of varieties to produce. Varieties most often selected and the percent of the crop planted in 2012 include: NC 71 (29%), NC 196 (20%), K 326 (15%), NC 297 (12%), NC 72 (4%), K 394 (6%), and others in smaller percentages to include: K 346, CC 27, Spt 70, Spt 168, NC 299, GF 318, and PVH 1452.

All tobacco sold in 2012 was sold under contract as no independent auctions were operated in Georgia and Florida. Five contract receiving stations representing five companies (Alliance One International (Nashville, GA), Philip Morris USA - (Altria Client Services) (Nashville, GA), R.J. Reynolds (Brookfield, GA), and U.S. Tobacco Cooperative (Nashville, GA), and Universal Leaf Tobacco (Douglas, GA) operated in Georgia and Florida.

Tobacco acreage in Georgia amounted to 9,600 acres in 2012, down from 11,500 acres in 2011 and 11,600 acres in 2010. Growers sold approximately 22,652,546 lbs of tobacco produced in 2012 at an estimated price of $1.90 per pound for an estimated farm gate total of $43,039,837. This compared to 31,133,000 lbs sold in 2011 for $56,040,000. The average price paid for tobacco in Georgia in 2011 was estimated at $1.90 per pound compared to $1.80 per pound in 2011. Average yields per acre were down from 2,700 in 2011 to 2,360 lbs/A in 2012.

INTRODUCTION TO THE 2013 GEORGIA TOBACCO BUDGETS

Flue- cured tobacco is one of the more expensive crops to produce. Large amounts of labor, chemicals and energy are required.

The accompanying budgets are designed to assist growers estimate their production costs. While per pound market prices have usually been greater than production costs, it is useful to better understand these costs when making production decisions.

As production practices and costs vary by farm, the budgets are designed to assist in estimating your own costs. Consider each cost item and compare this with your estimate for that item. Then enter your figure in the "Your Cost" column and see what the crop is costing you.

Returns to any inputs not listed, or zeroed out, in the budget will accumulate under profits. This means that a grower has the option of charging for an input. The same idea can be used for other inputs such as land, general overhead, management, operator labor, and risk of production. Realize that the level of profit is determined by how you count your costs.

FLUE-CURED TOBACCO - HAND HARVEST - BULK BARN
SOUTH GEORGIA AREA, 2013
ESTIMATED COSTS AND RETURNS ANALYSIS

EXPECTED YIELD (/ACRE): 2200 Lbs. YIELD: YOUR FARM _____

VARIABLE COSTS:	Unit	No. Units	Price /Unit	Cost /Acre	Cost /Lb.	Your Farm
PREHARVEST						
Plants	Thou.	7.00	$ 30.00	$ 210.00	$0.10	
Lime	Ton	0.33	33.00	10.89	0.00	
Fertilizer						
6-6-18 or Equiv.	Cwt.	14.00	34.00	476.00	0.22	
15.5-0-0 or Equiv.	Cwt.	1.50	35.00	52.50	0.02	
Nematicide-cont.or fum.	Acre	1.00	80.00	80.00	0.04	
Fungicide-Ridomil Gold,						
For Race 1 Blackshank	Pt.	2.00	92.00	184.00	0.08	
Herbicides	Acre	1.00	55.00	55.00	0.03	
Insecticides						
Soil - Admire	Oz.	12.50	4.00	50.00	0.02	
Soil - Actigard	Acre	1.00	2.00	2.00	0.00	
Foliar-Orth,Trac,Dipl	Appl.	4.00	11.50	46.00	0.02	
Sucker Control						
Contact - 4 Appl.	Gal.	6.00	14.00	84.00	0.04	
MH (2.25 lbs./gal.)	Gal.	1.00	15.00	15.00	0.01	
Prime +	Qt.	2.00	16.00	32.00	0.01	
Insurance- 65% Coverage	Dol.	2200.00	0.04	77.00	0.04	
Machinery						
Fuel - Diesel	Gal.	11.60	3.75	43.50	0.02	
Repairs and Maint.	Acre	1.00	57.47	57.47	0.03	
Irrigation	Appl.	6.00	14.50	87.00	0.04	
Electric Meter Charge	Month	12.00	2.00	24.00	0.01	
Labor, - Machinery	Hour	17.20	11.50	197.80	0.09	
Labor - Topping	Hour	14.00	11.50	161.00	0.07	
Other_____		0.00	0.00	0.00	0.00	
Interest on						
Operating Capital	Dol.	$1,945.16	0.060	$58.35	$0.03	
Total Preharvest Variable Costs				$2,003.51	$0.91	
HARVEST						
Curing Fuel - LP Gas*	Gal.	350.00	$1.50	$525.00	$0.24	
Electricity	Kwh	950.00	0.13	118.75	0.05	
Machinery:						
Fuel - Diesel	Gal.	8.00	3.75	30.00	0.01	
Repairs & Maint.	Acre	1.00	55.32	55.32	0.03	
Labor - Harvest,						
& Put in Barn	Hr.	48.00	11.50	552.00	0.25	
Unload & Bale	Hr.	8.00	11.50	92.00	0.04	
Baling Supplies	Bale	3.00	5.00	15.00	0.01	
Haul to Buying Station	Bale	3.00	9.00	27.00	0.01	
Other_____		0.00	0.00	0.00	0.00	
Total Harvest Variable Costs				$1,415.07	$0.64	
TOTAL ALL VARIABLE COSTS				$3,418.58	$1.55	

Footnotes Located At Bottom Of Next Page.

FLUE-CURED TOBACCO, HAND HARVEST, CONTINUED

FIXED COSTS:

PREHARVEST						
Machinery: Depreciation, Taxes, Investment, & Housing	Acre	1.00	$119.95	$119.95	$0.05	_____
Irrigation	Acre	1.00	60.00	60.00	0.03	_____
Owned Land Costs; Taxes, Cash Payment, Etc.	Acre	0.00	0.00	0.00	0.00	_____
Other_____		0.00	0.00	0.00	0.00	_____
Total Preharvest Fixed Costs				$179.95	$0.08	_____
HARVEST						
Curing Barn	Acre	1.00	$450.00	$450.00	$0.20	_____
Machinery: Depreciation, Taxes, Investment, & Housing	Acre	1.00	79.20	79.20	0.04	_____
Heat Exch Replacement**	Acre	1.00	80.00	80.00	0.04	_____
General Overhead	Dol.	$3,418.58	0.05	170.93	0.08	_____
Management ***	Dol.	$3,418.58	0.05	170.93	0.08	_____
Other_____		0	0.00	0.00	0.00	_____
Total Harvest Fixed Costs				$951.06	$0.43	_____
TOTAL ALL FIXED COSTS				$1,131.01	$0.51	

TOTAL COSTS AND PROFIT GOAL

Total Costs Excluding Land				$4,549.59	$2.07	_____

**** YOUR PROFIT GOAL ABOVE VARIABLE COSTS **** $ _____ Lb.

A&AE 12/2012

* If Diesel Is Used For Curing, Substitute Fuel Costs For 270 Gallons Of Diesel @ $3.75 / Gal., instead Of LP Gas Cost Estimate.

** Annual Cost of a Heat Exchanger is Based On An Initial Investment of $3,000 and a 10-Year Life, Five Cures Per Year.

*** Implies a return to the managerial ability of the farm operator. This return should be costed. If the operator were not working on a farm they could be earning a return in some other occupation.

FLUE-CURED TOBACCO - MACHINE HARVEST - BULK BARN
SOUTH GEORGIA AREA, 2013
ESTIMATED COSTS AND RETURNS ANALYSIS

EXPECTED YIELD (/ACRE): 2200 Lbs. YIELD: YOUR FARM _____

VARIABLE COSTS:	Unit	No. Units	Price /Unit	Cost /Acre	Cost /Lb.	Your Farm
PREHARVEST						
Plants	Thou.	7.00	$30.00	$210.00	$0.10	_____
Lime	Ton	0.33	33.00	10.89	0.00	_____
Fertilizer						
6-6-18 or Equiv.	Cwt.	14.00	34.00	476.00	0.22	_____
15.5-0-0 or Equiv.	Cwt.	1.50	35.00	52.50	0.02	_____
Nematicide-cont.or fum.	Acre	1.00	80.00	80.00	0.04	_____
Fungicide-Ridomil Gold,						
For Race 1 Blackshank	Pt.	2.00	92.00	184.00	0.08	_____
Herbicides	Acre	1.00	55.00	55.00	0.03	_____
Insecticides						
Soil - Admire	Oz.	12.50	4.00	50.00	0.02	_____
Soil - Actigard	Acre	1.00	2.00	2.00	0.001	_____
Foliar-Orth,Trac,Dip	Appl.	4.00	11.50	46.00	0.02	_____
Sucker Control						
Contact - 4 Appl.	Gal.	6.00	14.00	84.00	0.04	_____
MH (2.25 lbs./gal.)	Gal.	1.00	15.00	15.00	0.01	_____
Prime +	Qt.	2.00	16.00	32.00	0.01	_____
Insurance-75% Coverage	Dol.	2200	0.035	77.00	0.04	_____
Machinery						
Fuel - Diesel	Gal.	11.60	3.75	43.50	0.02	_____
Repairs and Maint.	Acre	1.00	57.11	57.11	0.03	_____
Irrigation	Appl.	6.00	14.50	87.00	0.04	_____
Electric Meter Charge	Month	12.00	2.00	24.00	0.01	_____
Labor - Machinery	Hour	17.20	11.50	197.80	0.09	_____
Labor - Topping	Hour.	14.00	11.50	161.00	0.07	
Other_____		0.00	11.50	0.00	0.00	_____
Interest on						
Operating Capital	Dol.	$1,944.80	0.060	58.34	0.03	_____
Total Preharvest Variable Costs				$2,003.14	$0.91	_____
HARVEST						
Curing Fuel - LP Gas*	Gal.	350.00	1.50	$525.00	0.24	_____
Electricity	Kwh	950.00	0.13	118.75	0.05	_____
Machinery:						
Fuel - Diesel	Gal.	21.50	3.75	80.63	0.04	_____
Repairs & Maint.	Acre	1.00	193.85	193.85	0.09	_____
Labor - Harvest,						
& Put in Barn	Hr.	24.00	11.50	276.00	0.13	_____
Unload & Bale	Hr.	8.00	11.50	92.00	0.04	
Baling Supplies	Bale	3.00	5.00	15.00	0.01	_____
Haul to Buying Station	Bale	3.00	9.00	27.00	0.01	_____
Other_____		0.00	0.00	0.00	0.00	_____
Total Harvest Variable Costs				$1,328.23	$0.60	_____
TOTAL ALL VARIABLE COSTS				$3,331.37	$1.51	_____

Footnotes Located At Bottom Of Next Page.

FLUE-CURED TOBACCO, MACHINE HARVEST, CONTINUED

FIXED COSTS:

PREHARVEST						
Machinery: Depreciation, Taxes, Investment, & Housing	Acre	1.00	$119.95	$119.95	$0.05	_____
Irrigation	Acre	1.00	60.00	60.00	0.03	_____
Owned Land Costs; Taxes, Cash Payment, Etc.	Acre	0.00	0.00	0.00	0.00	_____
Other_____		0.00	0.00	0.00	0.00	_____
Total Preharvest Fixed Costs				$179.95	$0.08	_____
HARVEST						
Curing Barn	Acre	1.00	$450.00	$450.00	$0.20	_____
Machinery: Depreciation, Taxes, Investment, & Housing	Acre	1.00	210.60	210.60	0.10	_____
Heat ExchReplacement**	Acre	1.00	80.00	80.00	0.04	_____
General Overhead	Dol.	3331.37	0.05	166.57	0.08	_____
Management ***	Dol.	3331.37	0.05	166.57	0.08	_____
Other_____		0.00	0.00	0.00	0.00	_____
Total Harvest Fixed Costs				$1,073.74	$0.49	_____
TOTAL ALL FIXED COSTS				$1,253.69	$0.57	

TOTAL COSTS AND PROFIT GOAL

Total Costs Excluding Land				$4,585.06	$2.08	_____

**** YOUR PROFIT GOAL ABOVE VARIABLE COSTS**** $ _____ Lb.

A&AE 12/2011

* If Diesel Is Used For Curing, Substitute Fuel Costs For 270 Gallons Of Diesel @ $3.75 / Gal. Instead Of LP Gas Cost Estimate.

** Annual Cost of a Heat Exchanger is Based On An Initial Investment of $3,000 and a 10-Year Life, Five Cures Per year.

*** Implies a return to the managerial ability of the farm operator. This return should be costed. If the operator were not working on a farm they could be earning a return in some other occupation.

ESTIMATED LABOR AND MACHINERY COSTS PER ACRE
TOBACCO, HAND HARVEST, 2013

Operation	Acres Per Hour	Number Times Over	Labor Use (Hr.)	Fuel Use (Gal.)	Machinery Repairs (Dol.)	Fixed Costs (Dol.)
PREHARVEST OPERATIONS:						
Plow	2.50	1.00	0.48	1.50	7.00	21.84
Disk	6.00	2.00	0.40	2.00	7.23	9.10
Disk & Appl. Herb.	6.00	1.00	0.20	0.70	3.82	10.69
Appl. Soil Insectcde.	4.00	1.00	0.30	1.00	6.20	12.90
Bed The Rows	4.00	1.00	0.30	1.70	4.23	13.65
Transplant	1.00	1.00	12.00	1.50	11.49	33.30
Cultivate	6.00	4.00	0.80	2.00	4.46	3.75
Spray - Tractor Mount	8.00	6.00	2.70	1.20	8.32	5.66
Top & Sucker-Crew Labor	2.00	0.00	0.00	0.00	0.00	
Total Preharvest Fuel, Repairs, Fixed Costs & Labor			17.18	11.60	52.75	110.89
HARVEST OPERATIONS:						
Hand Harvest-Crew Labor	1.00	5.00	30.00	10.00	25.74	37.35
Haul & Barn-Crew Labor	1.00	5.00	10.00	8.00	25.95	37.35
Remove & Bale	1.00	5.00	8.00			
Total Harvest Fuel, Repairs, Fixed Costs & Labor			48.00	18.00	51.69	74.70

ESTIMATED LABOR AND MACHINERY COSTS PER ACRE
TOBACCO, MECHANICAL HARVESTER, 2013

Operation	Acres Per Hour	Number Times Over	Labor Use (Hr.)	Fuel Use (Gal.)	Machinery Repairs (Dol.)	Fixed Costs (Dol.)
PREHARVEST OPERATIONS:						
Plow	2.50	1.00	0.48	1.50	7.00	21.84
Disk	6.00	2.00	0.40	2.00	7.23	9.10
Disk & Appl. Herb.	6.00	1.00	0.20	0.70	3.84	9.19
Appl. Soil Insectcde.	4.00	1.00	0.30	1.00	6.20	12.90
Bed The Rows	4.00	1.00	0.30	1.70	4.23	13.65
Transplant	1.00	1.00	12.00	1.50	11.49	33.30
Cultivate	6.00	4.00	0.80	2.00	4.26	3.75
Spray - Tractor Mount	8.00	6.00	2.70	1.20	8.19	5.66
Top & Sucker-Crew Labor	2.00	0.00	0.00	0.00	0.00	0.00
Total Preharvest Fuel, Repairs, Fixed Costs & Labor			17.18	11.60	52.44	109.39
HARVEST OPERATIONS:						
Combine Tobacco	1.00	5.00	5.00	13.50	166.25	171.00
Haul & Barn	1.00	5.00	19.00	8.00	25.95	37.35
Remove & Bale	1.00	5.00	8.00			
Total Harvest Fuel, Repairs, Fixed Costs & Labor			32.00	21.50	192.20	208.35

Returns Above Variable Costs ($1.55) Per Acre For Hand Harvested Flue Cured Tobacco, Various Yields and Contract Prices Compared to Variable Costs for a 2,200 lb Yield - 2013										
	Average Contract Price									
Yield	**$1.55**	**$1.60**	**$1.65**	**$1.70**	**$1.75**	**$1.80**	**$1.85**	**$1.90**	**$1.95**	**$2.00**
1,800 lbs.	-620	-530	-440	-350	-260	-170	-80	10	100	190
2,000 lbs.	-310	-210	-110	-10	90	190	-290	490	490	590
2,200 lbs.	-0	110	220	330	440	550	660	880	880	990
2,400 lbs.	310	430	550	670	790	910	1030	1270	1270	1390
2,600 lbs.	620	750	880	1010	1140	1270	1400	1660	1660	1790
2,800 lbs.	930	1070	1210	1350	1490	1630	1770	2050	2050	2190

Returns Above Variable Costs ($1.51) Per Acre For Machine Harvested Flue Cured Tobacco, Various Yields and Contract Prices Compared to Variable Costs for a 2,200 lb Yield - 2013										
	Average Contract Price									
Yield	**$1.55**	**$1.60**	**$1.65**	**$1.70**	**$1.75**	**$1.80**	**$1.85**	**$1.90**	**$1.95**	**$2.00**
1,800 lbs.	-532	-442	-352	-262	-172	-82	8	98	188	278
2,000 lbs.	-222	-122	-22	78	178	278	378	478	578	678
2,200 lbs.	88	198	308	418	528	638	748	858	968	1078
2,400 lbs.	398	518	638	758	878	998	1118	1238	1358	1478
2,600 lbs.	708	838	968	1098	1228	1358	1488	1618	1748	1878
2,800 lbs.	1018	1158	1298	1438	1578	1718	1858	1998	2138	2278

Farm Labor Management

Keith D. Kightlinger, Extension Economist

Employee or Independent Contractor?

Before a business operator can know his or her responsibilities, or how to treat payments made for services received, the relationship the business and the provider of services must be determined. In agricultural production businesses, providers of services generally fall into two categories: independent contractors, or common-law employees. Employees in agriculture include workers who:

- Raise livestock, bees, fur-bearing animals, or poultry
- Cultivate the soil, grow, or harvest crops
- Grow or harvest crops as the employees of a contractor
- As employees either the farmer or and independent contractor, do work on the farm which is incidental to the farming operations of that farm
- As employees of the farmer, do work of the farm which is incidental to the farming operations of the farm.

Common-law Employees

Under common-law rules, every individual who performs services subject to the will and control of an employer, as to both what must be done and how it must be done, is an employee. It does not matter that the employer allows the employee discretion and freedom of action, so long as the employer has the legal right to control both the method and the result of the services.

Independent Contractors

People engaged in an independent trade, business, or profession in which they offer their services to the general public are usually not considered to be employees. The general rule is that an individual is an independent contractor if the employer has the right to control or direct only the result of the work, and not the means and methods of accomplishing the result. Since independent contractors are not employees, no taxes are withheld or paid on payments made to them. If an independent contractor, other than a corporation, is paid $600 or more by any individual or firm during a calendar year, in the course of that individual or firm's trade or business, then the person or firm paying the independent contractor must complete IRS Form 1099 MISC, and provide the proper copy of the form to both the independent contractor and the Internal Revenue Service.

If an employer-employee relationship exists, it makes no difference how it is described by the parties involved. It does not matter how payments are measured, how they are made, or what they are called. Nor does it matter whether the individual is employed full time or part time. Employers may be required to withhold and pay taxes on wages paid to common-law employees.

Making the Determination

Employers are generally responsible for withholding and paying income, social security and Medicare taxes, and in some cases, unemployment taxes on wages paid to an employee. In the case of workers furnished to a farmer by a Farm Labor Contractor, the contractor and the farmer are considered to be joint employers under the Migrant and Seasonal Worker Protection Act. This legislation and its

regulations are discussed in the "Migrant and Seasonal Labor" section of this bulletin, Employers generally do not withhold or pay any taxes on amounts paid to independent contractors.

If uncertainty exists, the Internal Revenue Service has identified a number of factors indicating whether an employer-employee or independent contractor relationship exists. Form SS-8, "Determination of Employee Work Status for Purposes of Federal Employment Taxes and Income Tax Withholding," can be completed by either an employer or a worker, and to the IRS District Director for a determination. Many of the factors discussed on Form SS-8 follow.

- Training. An employee is trained to perform services in a particular way. Independent contractors use their own methods, and receive no training from users of their services.
- Instructions. Employees must comply with instructions about when, where, and how to work. Even if none are given, control exists if the employer has the right to instruct.
- Integration. An employee's services are integrated into the business operations because the services are important to the success or continuation of the business.
- Services rendered personally. An employee renders services personally. This shows that the employer is interested in the methods as well as the results.
- Hiring assistants. En employee works for an employer who hires, supervises, and pays assistants. An independent contractor hires, supervises, an pays assistants under a contract that requires him or her to provide materials and labor, and to be responsible only for the result.
- Continuing relationship. An employee has a continuing relationship with an employer. This relationship may exist where work is performed at frequently recurring, although irregular, intervals.
- Set hours of work. An employee's hours of work are set by an employer. An independent contractor is the master of his or her own time.
- Full-time work. An employee normally works full time for an employer. An independent contractor when and for whom he or she pleases.
- Work done on premises. An employee works on the premises of the employer, or works on a route or at a location designated by the employer.
- Order or sequence set. An employee performs services in the manner set by an employer. This shows that the employee is subject to direction and control.
- Reports. An employee submits reports to an employer. This shows that an employee must account for his or her actions.
- Payments. An employee is paid by the hour, week, month, or other specific unit. An independent contractor is paid by the job, or on a straight commission.
- Expenses. An employee's business and travel expenses are paid by an employer.
- Tools and materials. An employee is furnished significant tools, materials, and other equipment by an employer.
- Investment. An independent contractor has a significant investment in the equipment and/or facilities he or she uses in performing services for someone else.
- Profit or loss. An independent contractor can incur profit or loss.
- Works for more than one person or firm. An independent contractor gives his or her services to two or more unrelated persons or firms simultaneously.
- Offers services to the general public. Independent contractors offer their services to the general public.

- Right to fire. An employee can be fired. An independent contractor cannot be fired so long as he or she produces a result that meets the specifications of the contract.
- Right to quit. An employee can quit his or her job at any time without liability. An independent contractor usually agrees to complete a specific job and is responsible for its satisfactory completion, or is legally obligated to make good for failure to complete.

Employer Responsibilities

In 1938, the Fair Labor Standards Act was passed, creating a Federal minimum wage. Federal minimum wage law applies to agricultural employers who employ more than 500 man days of labor in a calendar quarter.

Man Day of Labor
A "Man Day" is defined for agricultural employment as "...any day during which an employee performs agricultural labor for not less than one (1) hour." Agricultural labor performed by the employer or member of his or her immediate family (spouse, parent, child, stepchild, or sibling) is not counted for the man day test, regardless of the form of business organization (sole proprietorship, partnership, or corporation) in "family" farms. Generally, a farm employer will have less than 500 man days of labor in a calendar quarter if he or she has five or fewer employees.

Example
George A. Farmer has five full-time hired employees who work at least one hour per day six days per week. He also currently has four seasonal employees who worked at least one hour per day six days per week for five weeks.

Mr. Farmer's man days of labor for the calendar quarter are:
Full time (5 workers x 6 days per week x 13 weeks) = 390 man days.
Seasonal (4 workers X 6 days per week x 5 weeks) = 120 man days.
Mr. Farmer employed 510 man days of labor during the calendar quarter. He will be subject to the agricultural provisions of the Fair Labor Standards Act in the next calendar year. He is not subject to the Act in the current year unless he had more than 500 man days of labor in any calendar quarter of the previous year.

The Minimum Wage
In 1997, the federal minimum wage was set at $5.15 per hour. The minimum wage remained at this level until 2007, when President George W. Bush signed legislation increasing the minimum wage as follows.

Date	Minimum Wage	
July 24, 2007	$5.85 per hour	
July 24, 2008	$6.55 per hour	
July 24, 2009	$7.25 per hour	(This rate is still the current effective rate.)

Agricultural employers who did not use more than 500 man days of labor during calendar quarter of the immediate prior year are exempt from minimum wage law during the current year.

The Fair Labor Standards Act is administered by the Wage and Hour Division of the United States Department of Labor.

Social Security and Medicare Taxes

Wages paid to farm workers are generally subject to Social Security and Medicare taxes. A few situations exist in which agricultural wages are exempt from Social Security and Medicare taxes.

- If the employer's total annual payroll is less than $2,500, the wages of employees earning less than $150 during that year are exempt.
- Wages paid by sole proprietors to their children less than 18 years of age are exempt, as are wages paid by partnerships and corporations to children less than 18 years of age, *if all of the partners/corporate officers are the parents of the children in question.*
- Wages paid for hand harvest labor are exempt if:
  - The employee is paid less than $150 and works on a piece-rate basis;
  - The employee commutes daily from his or her tax home, and
  - The employee worked for less than 13 weeks in agriculture during the previous calendar year.
- Wages paid to H-2(A) Program workers are by law not subject to Social Security and Medicare taxes.
- Payments to independent contractors are by definition exempt from withholding.

Tax Rates and Earnings Limits

The Social Security Administration determines the amount of earnings from wages, salaries, tips, and self-employment income that are subject to Social Security and Medicare taxes. Under current law, the amount of earnings annually subject to Old Age, Survivor and Disability Insurance (social security) tax is limited, but no annual limit exists on earnings subject to Medicare tax. Since 1990, the OASDI tax rate has been 6.2% of subject wages. The Medicare tax rate has been 1.45% 1986. In the case of common-law employees, Social Security and Medicare taxes are normally withheld form the employee's wages at the appropriate rate. In addition to the employee's withheld contributions, the employer makes a matching contribution, so that 12.4% of the employee's subject earnings are credited to his or her social security account, and 2.90% of his or her earnings are credited to the employee's Medicare account.

2013 Changes

The tax rate for the employee's share of social security (OASDI) tax paid after December 31, 2012 returns to 6.2%.

In 2013, the social security wage base limit (maximum wages subject to social security tax) is $113,700. The Medicare tax rate is 1.45% each for the employee and employer, unchanged from 2012. All wages are subject to the Medicare tax, without limit.

In 2013, the earnings subject to Social Security and Medicare taxes are:

Year	Social Security	Medicare
2013	$113,700	No limit

Additional information on earnings subject to Social Security and Medicare taxes, tax rates, and earnings limits can be obtained electronically from the Social Security Administration (http://www.ssa.gov), or from the Internal Revenue Service (http://www.irs.gov).

Since January 1, 1990, agricultural wages subject to Social Security and Medicare taxes have also been subject to federal income tax withholding.

Initial Paperwork

Employers are required to have on file for each employee Form W-4 (Employee's Withholding Allowance Certificate), and Form I-9 (Employment Eligibility Verification). A Federal Employer Identification Number (FEIN) is required for an employer to be able to deposit and report employment taxes withheld and paid. Business operators are able to obtain a FEIN online from the IRS at http://www.irs.gov/businesses/small/article/0,,id=102767,00.html.

Form W-4

Employees use Form W-4 to report the number of withholding allowances they are entitled to, based on marital status, number of dependents, other income, and amount of excess itemized deductions (above the employee's applicable standard deduction). The employer must have a completed Form W-4 from each employee to withhold the correct amount of federal income tax from the employee's wages. It is the employer's duty to supply Form W-4, and the employee's duty to truthfully complete the form and return it to the employer. If an employee fails to return Form W-4, the employer is required to withhold federal income tax from the employee's wages as if the employee is *single and claiming no withholding allowances*. This results in the maximum permissible amount of income tax being withheld from the employee's wages. Federal income tax withholding tables and withholding formulas are available from the Internal Revenue Service in Publication 15, Circular E, Employer's Tax Guide, or Publication 51, Circular A, Agricultural Employer's Tax Guide. Both of these publications, along with Form W-4, can be read online or downloaded from the IRS website at http://www.irs.gov/formspubs/lists/0,,id=97819,00.html.

Form I-9

Citizenship and Immigration Service Form I-9 is required to document that a worker is lawfully eligible for employment in the United States. Employers must have all new employees complete Form I-9 within three business days of hiring. Employers must have a completed Form I-9 on file for all employees who were employed on or after June 1, 1987. An employee's Form I-9 must be kept on file for minimum of three years, even if the employee has left. If an employee works more than three years, Form I-9 must be kept in the employer's file for one year after the employee's departure.

Georgia New Hire Reporting Program

The Georgia New Hire Reporting Program is a part of the federal Personal Responsibility and Work Opportunity Act (PRWORA) of 1996. The Act required the U.S. Department of Health and Human

Services to develop a National Directory of New Hires by October 1, 1997, and each State to develop a State Directory of New Hires by October 1, 1998. The program is designed to improve child support collection and reduce public assistance costs.

Georgia law requires employers to submit new hire information within **10** days of the date of hire. New hire information can be reported electronically through the Georgia New Hire Reporting Program website (http://www.ga-newhire.com). Multi-state employers may report newly hired employees to the state they are working, or they may select one state to report all new hires. Multi-state employers must notify the Secretary of the U.S. Department of Health and Human Services of their reporting choice.

Employee's full name	Employer's name (If partnership or corporation, use business name
Employee's address	Employer's Address
Employee's Social Security Number	Employer's Federal Employer Identification Number (Reports cannot be processed without FEIN)
Employee's date of birth (mm/dd/yyyy)	Employer's telephone number
Employee's date of hire (mm/dd/yyyy)	Multistate employer (if applicable)
Sate employee hired in	Medical insurance coverage availability

Employment Taxes and Deposits

Federal Payroll Tax Deposits
1Farm employers are classified as either **monthly** or **semi-weekly** depositors. Most farm businesses fall into the **monthly depositor** classification. If your FICA, Medicare and Federal Income taxes withheld totaled **$50,000 or less** for the "look back period," which is the second calendar year preceding the current calendar year (2009 for 2011), you are a monthly depositor. If the total taxes for the look back period exceed $50,000, you are a semi-weekly depositor. The only exceptions to the rules are for employers who accrue less than $1,000 in taxes for an entire year, and for employers who accrue $100,000 or more in payroll taxes during a single day.

2011 Payroll Tax Deposit Rule Changes Continue
Beginning January 1, 2011, employers are no longer able to deposit federal employment taxes (income, social security and Medicare taxes withheld and federal unemployment tax) using Federal Tax Deposit Coupons (Forms 8109 and 8109-B). Instead, these taxes must be deposited through the Electronic Federal Tax Payment System (EFTPS). Forms 8109 and 8109-B cannot be used after December 31, 2010, so January 2011 deposits of payroll taxes accrued in 2010 must be made through EFTPS.

Employers may enroll in EFTPS in three ways. The employer can enroll directly, either online through the EFTPS website (https://www.eftps.gov/eftps), or through the EFTPS Voice Response system, by calling 1-800-555-3453. Direct enrollment requires the employer to provide:

- The business Employer Identification Number EIN
- The business Name and Telephone Number
- The Name, Address and Telephone Number of the responsible individual representing the

business, and

- The Routing Number, Account Number and Account Type (checking or savings) for the bank account to be used.

Employers may also enroll indirectly, by asking a trusted third party such as a tax professional or a payroll tax service to make payments on their behalf. If this alternative is used, the third party will need the taxpayer's financial institution information.

Monthly Depositors

Employers who had less than $50,000 total payroll tax liability for the look back period are required to make deposit by the 15th day of the following month FICA and Medicare taxes withheld and/or accrued, and Federal Income tax withheld from employees' wages during each calendar month. For example, taxes withheld and/or accrued during January must been deposited in full on or before February 15. If the 15th of any month falls on a Saturday, Sunday, or any other day that is **not** a banking day, the taxes will be considered to be deposited in timely fashion if they are deposited on the next banking day after the 15th.

$1,000 Exception

If a farm employer accumulates less than $1,000 in payroll taxes during the entire year, no deposits are required, and the employer may pay the entire amount due with Form 943, in January of the following year. If the employer is uncertain whether payroll taxes will be less than $1,000 for the year, it is best to follow the monthly deposit rules, to avoid penalties for failure to make deposits in a timely manner.

Semi-Weekly Depositors

If your total Federal payroll taxes for the look back period were more than $50,000, you are classified as a semi-weekly deposited for the current year. Under these rules, taxes accumulated on payments made on Wednesday, Thursday and/or Friday must be deposited by the next Wednesday. Taxes accumulated on payments made on Saturday, Sunday, Monday and/or Tuesday must be deposited by the following Friday.

$100,000 One-Day Deposit Rule

If $100,000 or more in Federal payroll taxes is accumulated on any day during the year, you are required to deposit these taxes the **next banking day.** The employer then becomes a Semi-Weekly depositor for the remainder of the current calendar year and for the next year as well.

Georgia Income Tax

Employers are not required to withhold Georgia income tax from farm worker wages. However, employees may request that this tax be withheld and deposited for them also. To deposit withheld Georgia income taxes, you must register with the state. The *Taxpayer Registration Handbook* contains the State Tax Application Common Information Form, which must be completed to be issued a State Taxpayer Identifier (identification number). You should also request the Georgia *Employer's Tax Guide* and copies of Form G-4, Employee's Withholding Allowance Certificate. This is the state's version of Form W-4. Employees wishing to have both state and federal income taxes withheld should complete **both** forms, since withholding allowances may differ between state and federal.

Georgia Payroll Tax Deposit Rules
Employers withholding Georgia income tax from employee wages are required to deposit those taxes on behalf of employees in timely fashion. How frequently deposits must be made depends on the amount of tax withheld or required to be withheld.

Annual Filers
If the tax withheld or required to be withheld is less than $800 per year, the employer may pay the tax and file a G-7 Quarterly Reconciliation Return on or before January 31 of the following year. Requests to file annually must be made in writing and received in the Withholding Tax Section prior to April 30 of the year for which the annual filing request is being made.

Quarterly Filers
Employers whose tax withheld or required to be withheld is $200 per month or less, but more than $800 per year is required to file and remit payment with a G-7 Quarterly Reconciliation Return on or before the last day of the month following the end of the calendar quarter.

Monthly Filers
Employers whose tax withheld or required to be with-held exceeds $200 per month are required to file and remit payment with Form GA-V Payment Voucher on or before the 15th day of the following month, unless they are required to remit such payments electronically. Form GA-V is not required if there was no tax withheld for the quarter, or if payment was made via EFT. The employer is required to file a G-7 Quarterly Reconciliation Return, listing all payments made during the calendar quarter, on or before the last day of the month following the end of the quarter. Now required to be filed electronically.

Electronic Funds Transfer (EFT) Filers
For additional information regarding electronic funds transfer, contact the EFT Section of the Georgia Department of Revenue at 404-417-2220, 800-659-1855, or by email at doreft@ga.gov.

Coupon Books
Employers with active withholding tax identification numbers are mailed a coupon book in late December. Each book contains preprinted forms applicable to the filing frequency for that employer. New employers will receive a coupon book within four to six weeks after a withholding number is assigned. Additional withholding tax information and services is available from the Taxpayer Services Division by telephone at 404-417-3210, or by email at taxpayer.services@dor.ga.gov.

Unemployment Taxes

Agricultural employers are subject to Federal and State Unemployment Taxes if they meet **either** of two conditions **either this year or last year:**

- Payment of cash wages of $20,000 or more to farmworkers in any calendar quarter; or
- Employment of 10 or more farmworkers during any part of a day for at least one day during any 20 different weeks.

Subject employers must file reports with the proper State and Federal agencies and make timely payments of unemployment taxes. Employers are subject to both State and Federal Unemployment Tax liability. A credit applies against Federal Unemployment Tax Act (FUTA) liabilities for State Unemployment Tax Act (SUTA) liabilities paid.

Federal Unemployment Tax (FUTA) - August 1, 2011

FUTA is a 6.0 percent tax on the first $7,000 of wages paid to each employee. Employers paying SUTA receive a 5.4% credit against their FUTA liability, resulting in a 0.8 effective FUTA tax rate. FUTA is computed on wages paid from the beginning of the year, even if FUTA liability is triggered later in the year. FUTA is reported annually on Form 940 (Federal Unemployment Tax Return). The employer must calculate FUTA liability quarterly, and deposit the accrued tax whenever the liability exceeds $100 at the end of any calendar quarter. Deposits must be made by the end of the first month after the end of the quarter in which the accrued liability exceeds $100. Deposits are made at authorized financial institutions by submitting Form 8109 with the payment. FUTA deposits must be made with separate payment and Form 8109 from FICA/Medicare/Federal Income Tax deposits. If the accrued FUTA liability exceeds $100 at the end of the calendar year, the tax must be deposited in full with Form 8109 by January 31. If the end of the year liability is less than $100, the undeposited tax may be submitted with Form 940. FUTA regulation falls under the domain of the U.S. Department of Labor. Collection of FUTA deposits is handled by the Internal Revenue Service.

<u>The rules requiring the use of EFTPS beginning January 1, 2011 for certain tax deposits also apply to FUTA deposits.</u>

State Unemployment Tax (SUTA)

SUTA in Georgia is computed on the first $8,500 of wages paid to each employee of a subject employer. SUTA must be computed on employee wages from the beginning of the year, even if SUTA liability is not triggered until later in the year. Employers newly subject to SUTA are assessed at a rate of 2.70 percent. This rate consists of two components; 2.64 percent unemployment tax, and 0.06% administrative assessment. The rate of tax paid by an employer is subject to change, based on the employer's ratio of contributions paid in to benefits paid out, and the statewide ratio of Georgia's trust funds to Georgia's covered wages. Employers newly liable for SUTA should contact their nearest Department of Labor office and request Form DOL-1A (Employer Status Report), to apply for a SUTA identification number and Publication DOL-224 (Unemployment Insurance: The Employer's Handbook). Georgia employers subject to SUTA must file Form DOL-4 quarterly to report their

SUTA-taxable wages paid to each employee, and to make payment of tax. SUTA payments are submitted directly to the Department of Labor with Form DOL-4. Form DOL-4 is sent to registered employers quarterly and must be completed and returned with payment by the end of the month following the last month of a calendar quarter. Failure to receive Form DOL-4 does not relieve the employer of his or her timely filing and payment requirements.

Migrant and Seasonal Labor

Producers of labor intensive crops often utilize seasonal or migrant labor in their businesses. While some farmers recruit their own seasonal labor forces, many rely on Farm Labor Contractors to recruit, transport, house, and pay migrant and seasonal workers.

Legislation

Producers using migrant and/or seasonal workers must be aware of laws relating to the payment, transport, and housing of these workers. Producers must also be familiar with the regulations governing the licensing and actions of Farm Labor Contractors, and of their own responsibilities and liabilities when using the services of migrant and/or seasonal workers, whether their services have been obtained directly by the producer, or through a Farm Labor Contractor.

The Fair Labor Standards Act of 1938 (FSLA) and the Migrant and Seasonal Worker Protection Act of 1983 (MSPA) are the principal pieces of Federal legislation governing the payment and treatment of farm workers. Both of these legislative acts are administered and enforced by the Wage and Hour Division of the U.S. Department of Labor.

Fair Labor Standards Act

Agricultural employers must understand the term "man day," as defined in the Fair Labor Standards Act, as the man days of labor used in a farm business determine whether the farm employer is subject to both minimum wage law and to the Migrant and Seasonal Worker Protection Act.

A "Man Day" is defined for agriculture as "...any day during which an employee performs agricultural labor for not less than one (1) hour." Agricultural labor performed by the employer, or by any member of his or her immediate family (spouse, parent, child, stepchild, or sibling) is not included in counting man days, regardless of the form of business organization (sole proprietorship, partnership, or corporation) in "family" farms.

Generally, a farm employer will fall under the 500 man day per calendar quarter limit if there are five or fewer employees. Man days of labor for this calculation include both man days of labor employed directly by the producer, and man days of labor employed through a Farm Labor Contractor.

Example

Belle Pepper has two full-time non-family employees who work at least one hour per day six days per week. She also currently has 12 migrant workers employed through a Farm Labor Contractor who have worked at least one hour per day six days per week for five weeks. Belle's man days of labor for the calendar quarter are:

Full-time (2 workers x 6 days x 13 weeks) = 156 man days.
Migrant (12 workers x 6 days x 5 weeks) = 360 man days.

Belle has employed 516 (156 + 360) man days of labor during the calendar quarter. She will be subject to minimum wage law for her own employees next year. She is not subject to minimum wage law for her own employees this year, unless she employed more than 500 man days of labor in any calendar quarter in the previous year.

Belle is subject to minimum wage law this year for the migrant workers she has utilized if the Farm Labor Contractor is currently subject to paying minimum wage. She is also subject to the Migrant and Seasonal Worker Protection Act if the Contractor is subject.

Migrant and Seasonal Worker Protection Act
A farmer is considered to be a joint employer of migrant and seasonal workers brought to his farm by a Farm Labor Contractor under the Migrant and Seasonal Worker Protection Act.

If the farmer has input with respect to the housing and/or transportation of workers, the farmer also has responsibility for these items under MSPA. The farmer shares liability for worker housing, even when housing is provided by the Farm Labor Contractor. All housing used by migrant and seasonal workers must be inspected by one of three agencies: the U.S. Department of Labor; the Georgia Department of Labor; of the U.S. Occupational Safety and Health Administration (OSHA).

Regulations
The following Migrant and Seasonal Worker Protection Act regulations apply both to Farm Labor Contractors, and to growers functioning as their own contractors.

- Registration. Farm Labor Contactors must register annually with the U.S. Department of Labor to receive a Farm Labor Contractor Certificate.
- Transportation. Farm Labor Contractors transporting workers must register the vehicles used with the Department of Labor, and have an annual safety inspection of each vehicle. The VIN, make, and description of each vehicle certified for worker transport is printed on the contractor's Certificate. Parties transporting workers are required to have minimum of $100,000 insurance per vehicle seat (up to a maximum total requirement of $5 million for vehicles with 50 or more seats), or participate in Workers Compensation. Drivers of vehicles designed to carry more than 15 passengers must have a Commercial Driver's License of the proper class for the vehicle they drive, and a passenger endorsement for the license.
- Housing. Farm Labor Contractors providing housing for workers must be "Housing Certified" on their Certificate, and the facilities used inspected, approved, and listed by address on their Certificate.
- Compensation. Farm Labor Contractors and farmers employing migrant and/or seasonal workers directly usually must pay workers at rates at least equal to minimum wage. Piece-rate payment is acceptable, so long as the pay rate is at least equal to the current federal minimum wage, when computed on an hourly basis. The wage rate test applies to the total time workers are required to be on the farm, not just to the time work is actually performed. The contractor and the farmer are jointly liable for the payment of proper wages, and for the withholding, accrual, and depositing of all applicable payroll taxes. If the Farm Labor Contractor fails to

meet payroll responsibilities, the appropriate government agencies will seek payment from the farmer.

The only regulation without dual application is the requirement for registration. Farmers recruiting, paying, housing, and/or transporting migrant and seasonal workers for their own business are not required to register with the U.S. Department of Labor and be certified as Farm Labor Contractors, but they are subject to all other regulations affecting registered contractors.

Considerations for Farmers using the services of Farm Labor Contractors

- Work only with registered Farm Labor Contractors. Only currently registered contractors have the legal authority to enter into an agreement with a grower.
- Vehicles used by a contractor to transport workers must:
  - Be listed on the contractor's certificate;
  - Be in current safe condition;
  - Be properly insured; and
  - Have a properly licensed driver.

  If workers are not being transported by the contractor, ask how workers will arrive at the job site, and how they will be transported while on the job.

  If you (the grower) transport workers, you must meet the same vehicle condition, insurance, and driver licensing requirements outlined in the second through fourth items in the bullet list immediately above.
- If worker housing is provided by the Farm Labor Contractor, be certain that the sites are listed on the contractor's certificate, and that the facilities have passed, or will pass inspection prior to the arrival of workers.

  Growers providing housing for migrant or seasonal workers should have their housing units inspected and approved prior to the arrival of workers.
- Verify that workers are being paid at a rate at least equivalent to the current minimum wage, and that all applicable payroll taxes are being correctly withheld, accrued, and deposited in a timely manner. If payroll management issues are a concern, be prepared to provide assistance to the contractor in this area.
- Never forget your shared liability for migrant and seasonal workers, as a joint employer of workers furnished by a Farm Labor Contractor.

H-2A Program Workers

The H-2A program is authorized by the Immigration and Nationality Act, as amended by the Immigration Reform and Control Act of 1986. The program is intended to assure agricultural employers an adequate labor force, while protecting the jobs and wages of U.S. workers. The U.S. Citizenship and Immigration Service, the U.S. Department of Labor, Wage and Hour Division, and the Georgia Department of Labor, Agriculture and Alien Labor Certification Section are all involved in the administration and/or enforcement of the H-2A program.

Who May Apply
An agricultural employer who needs workers to perform labor or services of a temporary or seasonal nature may apply. An employer may be an individual, a partnership, a corporation, or an association of agricultural producers. An authorized agent may also apply on behalf of an employer.

Granting of Certification
A temporary labor certification permitting use of aliens will not be granted until it is shown that there are not sufficient U.S. workers available for the job, and that the employment of aliens will not adversely affect U.S. workers. If a labor certification is granted, it is the employer's responsibility to arrange for the admittance of aliens into the United States by filing visa applications for the temporary alien workers with the U.S. Citizenship and Immigration Service.

When to Apply
Applications must be filed with Agriculture and Alien Labor Certification Section of the Georgia Department of Labor and the appropriate U.S. Department of Labor, Regional Administrator, Employment and Training Administration, at least 60 calendar days before the first date on which workers are needed. If the application is acceptable, the Regional Administrator will make a certification determination 20 calendar days before the date on which the workers are needed. Applications may be filed in person, mailed certified return receipt requested, or delivered by guaranteed commercial delivery to the appropriate Regional Administrator and local office of the State Employment Service.

Documents to be submitted include:
- Application for Alien Employment Certification (Form ETA 750, Part A. Offer of Employment);
- Agricultural and Food Processing Clearance Order (Form ETA 790);
- Attachments as appropriate to supplement information in the above forms, and;
- Statement of authorization of agent or association, if applicable.

Conditions to be Satisfied
Employment of H-2A program workers imposes a number of conditions on employers which are not found in other employment situations. The conditions apply to all workers employed for H-2A contract work. U.S. citizens and nationals, resident aliens and non-resident aliens performing the same work under the terms of an H-2A employment contract must be treated equally in all respects of the H-2A contract.

Specific Conditions to be Satisfied
- **Recruitment:** The employer must first actively attempt to recruit U.S. workers. The effort must at least equal the recruiting efforts of non-H-2A agricultural employers with respect to U.S. workers in the area of expected labor supply.
- **Wages:** The rate of pay must be the same for U.S. workers and H-2A workers. The rate must also be the higher of the applicable Adverse Effect Wage Rate (AEWR), or the applicable local prevailing wage rate. For 2012 the AEWR for Georgia was $9.39 per hour. The AEWR is adjusted annually, and can be different in different states. The current AEWR for each state can be found at http://www.foreignlaborcert.doleta.gov/adverse.cfm. Adjusted AEWRs are

also published annually (usually in February) in the Federal Register. Payments to H-2A workers are not subject to Social Security and Medicare taxes; Federal and State Income Taxes; or to Federal or State Unemployment Taxes.

- Housing: The employer must provide free approved housing to all workers who are not able to return to their residences the same day.
- Meals: The employer must provide workers either three meals per day, or furnish cooking and kitchen facilities for workers to prepare their own meals. If meals are provided, in 2010 the employer may charge each worker up to $10.94 per day for three meals per day. Adjustments to the maximum allowable meal charges are based on the change in the Consumer Price Index for all Urban Consumers of Food (CPI-U for Food) for the fiscal year ending the immediately previous November 30. Adjustments are published annually in the Federal Register, usually in February.

Transportation: The employer is responsible for

  - Reimbursement of transportation and subsistence costs from the recruitment point to the place of work, after 50% of the contract period is completed.
  - Transportation between any required housing site and the worksite for any worker who is eligible for such housing.
  - Return transportation or transportation to the next job, upon completion of the work contract.

- Workers' Compensation Insurance: The employer must provide Workers' Compensation or equivalent insurance for all workers.
- Tools and Supplies: The employer must furnish all needed tools and supplies.
- Three-fourths Guarantee: The employer must guarantee employment for at least 3/4ths of the workdays in the work contract period, and any extensions.
- Fifty Percent Rule: The employer must employ any qualified U.S. worker who applies for work during the first half of the contract period.
- Labor Dispute: The employer must assure that the job for which H-2A certification is requested is not vacant due to a strike or lockout.
- Certification Fee: The employer must pay a fee of $100, plus $10 per job opportunity certified, up to a maximum of $1,000 for each certification granted.
- Other Conditions: Each worker must receive a copy of the work contract. Employers must keep accurate records of workers' earnings. Each worker must be provided with a complete statement of hours worked and related earnings on each payday. Workers must be paid at least twice monthly. Employers are required to furnish all H2-A contract information in a language common each worker.

2013 TOBACCO VARIETY INFORMATION

J. Michael Moore
Paul Bertrand
Steve LaHue

New Varieties for 2013

CC 1063 (Cross Creek Seed Company) met the minimum standards in 2011. CC 1063 has resistance to black shank and Granville Wilt and root knot nematodes. This variety is susceptible to tobacco mosaic virus.

PVH 2275 (F. W. Rickard Seed Company) met the minmum standards in 2010. PVH 2275 is a good yielding variety. Black shank Race O resistance is high with resistance to southern root knot nematode and tobacco cyst nematode as well as having moderate resistance to *Meloidogyne arenaria.* This variety is resistant to tobacco mosaic virus and potato virus Y.

GF 318 (Gwynn Farms) It met minimum standards in 2008. GF 318 is a high yielding variety.. The black shank rating is a 13 and the Granville wilt resitance is rated as 14, with resistance to root knot nematode. Available from Gold Leaf Seed Company.

GL 338 (Gold Leaf Seed Company) GL 338 met the minimum standards in 2009. It is a high yielding variety with moderate black shank and Granville wilt resistance. Available from Gold Leaf Seed Company.

NC 92 (F. W. Rickard Seed Company) It met minimum standards in 2007. NC 92 is a high yielding variety. NC 92 is resistant to black shank Race O, the southern root-knot nematode and the tobacco cyst nematode. NC 92 has moderate resistance to black shank Race 1 and bacterial wilt. This variety is susceptible to tobacco mosaic virus. Available from F.W. Rickard Seed Company.

Seed Company Contact Information

Cross Creek Seed	PH: 910 904 1888	http://www.goldleafseed.com/us/index.php
Gold Leaf Seed Company	PH: +1 (800) 281-2541	http://www.crosscreekseed.com/
F. W. Rickard Seed Company	PH: +1 800 344 0630	http://www.rickardseed.com/
ProfiGen do Brasil Ltda	PH: (55)(51) 3704-9244	http://www.profigen.com/
Raynor Seed Company	PH: (252) 446-5229	

GROWERS ARE ENCOURAGED TO PLANT ONLY A LIMITED ACREAGE OF ANY NEW VARIETY UNTIL MORE INFORMATION AND EXPERIENCE BECOMES AVAILABLE FROM A WIDER RANGE OF SOIL AND CLIMATIC CONDITIONS.

Variety Selection

All tobacco varieties undergo rigorous testing before being released for commercial production. This testing includes small plot trials on experiment stations, warehouse evaluations, determination of chemical and physical properties, and finally on-farm testing to evaluate how the potential variety performs in a commercial situation. A variety must meet certain quality standards before being released. Thus farmers can be assured that any variety that is released has been thoroughly evaluated before seed are made available for commercial planting.

Each farmer may have different requirements for the variety to be grown on his farm. Ease of growing and curing, disease and nematode resistance and market acceptance should be taken into account when selecting a variety. Since disease and nematode infestations on a farm can seriously limit variety selection, farmers should attempt to keep their fields free of these problems. Crop rotation is necessary on most farms to reduce losses from soil-borne diseases and nematodes.

Growers should not depend solely on varietal resistance to prevent losses from diseases and nematodes. Crop rotations and appropriate chemicals should be a part of every tobacco program no matter which variety is grown. In severely infested fields, there will usually be some loss to black shank with any variety. Chemicals are available to reduce black shank damage. Three year or longer crop rotation is a proven means of reducing black shank losses. Rotation among a group of black shank resistant varieties will prolong resistance of any one variety. This practice is most valuable where crop rotations are shortest. Nematode-resistant varieties have resistance only to races 1 and 3 of Southern root-knot nematode. Losses to peanut, Javanese and race 2 or 4 of Southern root-knot nematodes have been increased by short-term rotations, growing varieties resistant to races 1 and 3 of Southern root-knot nematode and improper use of nematicides. Rotating tobacco with nematode-resistant crops and effective use of nematicides are essential to preventing losses to nematodes.

Several agronomic characteristics may assist in the selection of a variety. Yield, quality, sucker habits, height, leaf spacing, leaf size and maturity characteristics are available. Some characteristics may be more affected by cultural practices than by varietal differences.

2012 Official Flue-Cured Tobacco Variety Evaluation

Tobacco varieties play a discerning role in yield and quality improvement programs. Moreover, a vital part of any breeding program is the appropriate testing and evaluation of new tobacco varieties. Important characteristics of these varieties are yield, disease resistance, desirable plant qualities, ease of handling, and market acceptability. For a variety to be recommended it must be superlative in one or more and contain a balance of the remainder of the factors. For instance, for a variety to have an excellent yield and poor disease resistance or to yield well and have poor cured quality is undesirable.

The Regional Variety Test is conducted to obtain data on yield, disease resistance, quality as judged by physical appearance, and chemical analysis for quality characteristics. Once this information is analyzed, the desirable varieties and breeding lines in these tests advance to the Official Variety Test for further evaluation under growing and marketing conditions in Georgia.

As in previous years, we have included the Regional Farm Test so that when varieties are selected from this test the extension service will have a second data set to use in making recommendations to growers.

The 2012 Official Variety Test and Regional Small Plot Test consisted of 24 and 26 entries respectively while the Farm Test had 16 entries. These tests were conducted at the University of Georgia Bowen Farm on Ocilla

loamy coarse sand. All transplants were treated with Actigard (1 oz/100,000 cells) and imidacloprid (0.8 oz Admire Pro/ 1000 plants) for Tomato spotted wilt virus (TSWV) and followed with one field spray (April 25) of Actigard applied at 0.5 oz/A at the first sign of TSWV symptoms in non-treated border rows. The Official Variety Test was mechanically transplanted on April 3. The Regional Farm and Regional Small Plot Tests followed on April 4. All tests were transplanted with 22-24 plants per field plot and replicated three times. Fertilization consisted of 6 lb/A of 9-45-15 in the transplant water, 500 lbs/acre of 6-6-18 at first cultivation, 600 lbs/acre 6-6-18 at second cultivation, and an additional 120 lbs/acre of 15.5-0-0 at lay-by for a total of 85 lbs/acre of nitrogen.

Cultural practices, harvesting, and curing procedures were uniformly applied and followed the current University of Georgia recommendations. Data collected included plant stand, yield in lbs/A, value/A in dollars, dollars per hundred weight, grade index, number of leaves per plant, plant height in inches, days to flower and percent TSWV. In addition, leaf chemistry determinations consisted of total alkaloids, total soluble sugars, and the ratio of sugar to total alkaloids.

Results and Discussion

The 2012 Official Variety Test and Regional Farm Test produced average yields and good quality through moderate growing conditions. The tests benefitted from the application of Telone II, applied at the recommended rate, in October 2011 with good soil conditions which kept nematode pressure to a minimum. In addition, a field spray of Actigard combined with the standard tray drench treatment and light disease pressure resulted in a test average of 2.3% TSWV symptomatic plants. However, inconsistent rains required 9 irrigations which delivered approximately 8 inches of water on top of 11.6 inches of rain which fell during the test period.

In the Official Variety Test, yield ranged from 2365 lbs/A for GF 157 to 3017 lbs/A for K 326. Value of released varieties ranged from 2670 dollars/A for NC 2326 to 4942 dollars/A for CC 700. Prices were up from 2011 with NC 2326 at $113/cwt at the low end while PVH 2110 at $178 had the best price per cwt for the released varieties. Grade index ranged from 55 for NC 2326 to 86 for PVH 2110. Plant heights averaged near 40 inches while leaf numbers per plant were close to 20. Most flowering dates averaged 8 or more days later than NC 2326 which was at 67 days. Leaf chemistry was excellent with sugars averaging in the upper teens and alkaloids generally below 2.5. The Official Variety Test data are displayed in Table 1. Two and three year averages for selected varieties are found in Table 2.

The 2012 Regional Farm Test yielded better and graded out lower than the other tests. In the Farm Test (Table 3), NC 2326 had the lowest yield at 2572 lb/A. NCEX 39 yielded the highest at 3579 lbs/A. Value ranged from 2964 dollars/A for NC 2326 to 5476 dollars/A for ULT 113. ULT 113 graded the best bringing in $162/cwt and having a grade index of 79. The lowest, CU 124 had a grade index of 52 with a price of $106/cwt. PXH 1 had the best leaf chemistry with low alkaloids (2.06%) and good sugars (17.0%). Generally, leaf chemistry was similar to the Official Variety Test, with sugars in the upper teens and alkaloids generally below 2.7.

The Official Variety test data are displayed in Tables 1 and 2 and the Farm test data are displayed in Table 3.

Disease resistance ratings for selected released varieties are presented in Table 4. Pedigree, year of release and sponsor of selected varieties are presented in Table 5. Pedigree, year of release, sponsor and diease resistance of selected released varieties grown on-farm in Columbia County, Florida are presented in Table 6. Agronomic and economic information on selected released varieties grown on-farm in Columbia County, Florida are presented in Table 7.

Table 1. Yield, Value, Price Index, Grade Index, and Agronomic Characteristics of Released Varieties Evaluated in the 2012 Official Flue-Cured Variety Test at the University of Georgia, Tifton, GA.

Variety	Yield (lb/A)	Value ($/A)	Price[1] Index ($/cwt)	Grade[2] Index	Number Leaves/ Plant	Plant Height (in)	Days to Flower	Total Alkaloids (%)	Reducing Sugars (%)	Ratio RS/TA
NC 2326	2373	2670	113	55	16	35.0	67	2.89	17.9	6.19
NC 95	2946	3482	119	58	19	41.1	75	3.70	15.8	4.28
K 326	3017	4461	148	70	19	37.7	79	2.11	19.0	9.01
K 346	2375	3305	140	70	19	40.1	76	2.21	18.4	8.34
K 399	2708	3833	141	73	19	37.7	74	2.31	19.4	8.37
NC 71	2550	3956	146	76	18	38.3	78	2.14	19.0	8.87
NC 72	2871	4026	140	70	17	37.8	76	1.87	19.1	10.18
NC 92	2825	3218	114	57	19	40.5	76	2.41	19.5	8.09
NC 196	2499	3937	159	78	18	37.5	80	2.04	19.7	9.68
NC 925	2791	4035	144	72	17	39.9	75	2.43	18.5	7.62
NC 297	2752	3659	132	66	19	36.1	77	2.26	17.3	7.64
CC 27	2628	3575	136	68	19	39.3	78	1.84	17.0	9.23
CC 33	2725	4529	165	81	19	39.2	78	2.29	18.0	7.88
CC 35	2963	4593	154	76	20	40.3	81	2.15	18.4	8.52
CC 37	2652	3592	134	66	19	38.2	79	1.99	18.8	9.47
CC 65	2781	3910	140	71	19	39.9	82	2.53	17.3	6.85
CC 67	2621	4271	162	80	20	40.0	73	2.52	14.6	5.80
CC 700	2985	4942	164	81	18	39.2	77	1.95	17.7	9.10
CC 1063	2599	4177	160	79	18	37.9	76	2.40	18.1	7.55
PVH 1452	2686	4340	161	80	19	39.7	78	2.30	17.8	7.72
PVH 2110	2727	4851	178	86	21	40.2	82	1.96	16.7	8.55

Table 1. Yield, Value, Price Index, Grade Index, and Agronomic Characteristics of Released Varieties Evaluated in the 2012 Official Flue-Cured Variety Test at the University of Georgia, Tifton, GA. *(continued)*

Variety	Yield (lb/A)	Value ($/A)	Price[1] Index ($/cwt)	Grade[2] Index	Number Leaves/ Plant	Plant Height (in)	Days to Flower	Total Alkaloids (%)	Reducing Sugars (%)	Ratio RS/TA
PVH 2254	2691	4672	174	85	19	39.3	79	1.96	21.7	11.06
PVH 2275	2589	4112	158	78	19	38.7	74	2.31	16.8	7.30
Speight 168	2822	4213	150	75	19	38.8	80	2.37	17.0	7.17
GL 338	2633	4340	165	81	18	38.8	72	2.38	17.4	7.30
GL 395	2446	3856	158	79	19	38.4	73	2.03	16.2	7.97
GF 157	2365	3522	148	73	19	38.5	74	2.25	15.2	6.73
GF 318	2975	4375	146	73	20	39.9	75	2.07	18.8	9.09
RJR 901	2424	3489	146	73	19	39.4	78	2.28	17.5	7.69
LSD@0.05	382.9	1140.7	30.9	14.2						

[1]Price Index based on two year average (2011-2012) prices for U.S. government grades.
[2]Numerical values ranging from 1-99 for flue-cured tobacco based on equivalent government grades - higher the number, higher the grade.

Table 2. Comparison of Certain Characteristics for Released Varieties Evaluated in the 2012 Official Flue-Cured Tobacco Variety Test at the University of Georgia, Tifton, GA.

Variety	Yield (lb/A)	Value ($/A)	Price[1] Index ($/cwt)	Grade[2] Index	Number Leaves/ Plant	Plant Height (in)	Days to Flower	Total Alkaloids (%)	Reducing Sugars (%)	Ratio RS/TA
3 Year Average (2010, 2011 and 2012)										
NC 2326	2310	2844	123	61	17	36	66	2.64	14.5	5.45
NC 95	2616	3632	140	69	19	40	77	3.02	15.3	5.17
K 326	2933	4565	154	76	19	36	78	2.45	15.8	6.67
K 346	2663	3454	132	68	18	38	75	2.42	15.7	6.59
K 399	2830	3955	140	72	19	36	76	2.34	18.3	7.82
NC 71	2817	4067	143	74	19	36	77	2.32	16.5	7.19
NC 72	3002	3996	135	69	18	38	77	2.38	15.7	6.96
NC 92	3035	3394	114	60	19	40	77	2.65	16.2	6.28
NC 196	2975	4294	147	74	19	39	80	2.33	17.5	7.71
NC 297	2835	3788	135	69	19	36	78	2.58	16.5	6.56
CC 27	2930	3822	131	67	20	38	75	2.27	14.8	6.87
CC 37	3096	3994	130	66	17	40	79	2.18	17.1	7.92
CC 65[3]	3341	4076	122	64	20	41	82	2.71	15.1	5.65
CC 67	2676	3744	139	71	19	37	75	2.25	16.4	7.46
CC 700	3015	4442	147	74	19	38	76	2.61	16.4	6.63
PVH 1452	3086	4441	146	74	19	38	76	2.52	16.2	6.47
Speight 168	3033	4280	143	72	18	37	77	2.30	16.2	7.14
GL 338	2907	4158	145	70	18	38	71	2.59	16.4	6.37
GF 318	3257	4675	144	67	20	40	76	2.47	18.1	7.61

Table 2. Comparison of Certain Characteristics for Released Varieties Evaluated in the 2012 Official Flue-Cured Tobacco Variety Test at the University of Georgia, Tifton, GA.*(continued)*

Variety	Yield (lb/A)	Value ($/A)	Price[1] Index ($/cwt)	Grade[2] Index	Number Leaves/ Plant	Plant Height (in)	Days to Flower	Total Alkaloids (%)	Reducing Sugars (%)	Ratio RS/TA
2 Year Average (2011 and 2012)										
NC 2326	2264	2460	109	54	17	35	66	2.72	15.8	5.78
NC 95	2836	3950	141	70	19	40	74	3.18	15.0	4.78
K 326	3046	4917	161	80	19	36	77	2.21	16.2	7.44
K 346	2745	3236	121	63	18	37	77	2.41	16.5	6.95
K 399	2970	3926	132	70	19	36	74	2.36	18.7	7.91
NC 71	2948	4172	138	73	18	37	78	2.28	17.0	7.55
NC 72	3050	3794	126	66	18	37	78	2.27	16.5	7.70
NC 92	3195	3187	101	54	20	40	78	2.80	17.0	6.32
NC 196	3069	4171	140	72	19	38	80	2.40	18.1	7.81
NC 297	3037	3877	128	67	19	36	78	1.71	16.7	6.40
CC 27	2945	3734	128	66	19	38	75	2.33	15.0	6.92
CC 37	3117	3795	123	64	19	39	79	2.07	18.1	8.76
CC 65	3075	3563	117	63	20	41	82	2.57	16.4	6.37
CC 67	2780	3829	137	71	19	39	74	2.22	16.6	7.75
CC 700	3170	4676	148	75	19	38	75	2.55	16.3	6.91
PVH 1452	3080	4261	141	73	19	38	76	2.50	17.1	9.93
Speight 168	3160	4320	138	71	19	38	78	2.17	16.8	7.82
GL 338	2954	4108	142	68	18	37	72	2.54	17.1	6.76
GL 395	2874	4085	144	75	19	38	76	2.21	15.6	7.14
GF 318	3304	4592	140	63	19	38	75	2.18	18.7	8.60

Table 3. Yield, Value, Price Index, Grade Index and Agronomic Characteristics of Varieties Evaluated in the 2012 Regional Farm Test at the University of Georgia, Tifton, GA.

Variety	Yield (lb/A)	Value ($/A)	Price[1] Index ($/cwt)	Grade[2] Index	Number Leaves/ Plant	Plant Height (in)	Days to Flower	Total Alkaloids (%)	Reducing Sugars (%)	Ratio RS/TA
NC 2326	2572	2964	118	56	17	37.7	66	3.15	15.6	4.97
NC 95	3946	3644	123	61	19	40.2	74	2.59	17.2	6.65
K 326	3298	4438	135	67	20	17.3	71	2.74	17.8	6.50
CU 124	3163	3367	106	52	22	37.2	78	2.66	16.7	6.29
ULT 143	3291	3906	119	59	20	38.5	73	2.70	16.7	6.18
PXH 1	3081	3742	123	60	20	37.9	79	2.06	17.0	8.27
GLEX 362	3322	4601	139	69	21	38.4	71	2.67	17.5	6.57
NCEX 39	3579	3982	111	55	18	37.4	72	2.56	17.6	6.91
GLEX 328	3528	4800	137	67	19	38.5	74	2.23	17.4	7.80
CC 143	3356	4595	137	68	19	40.1	71	2.32	16.2	6.95
PXH 9	3541	4689	134	66	19	38.9	70	2.40	17.5	7.31
NCEX 24	3418	4541	133	66	18	39.8	74	2.46	18.2	7.39
ULT 113	3366	5476	162	79	18	38.8	69	2.63	16.9	6.42
CU 144	3174	4371	140	67	19	39.1	70	2.52	18.2	7.25
ULT 123	3426	5024	148	73	20	40.4	70	2.31	18.5	8.03
NC EX 38	3344	4264	127	64	19	38.5	70	2.40	17.1	7.13
LSD@0.05	265.3	745.2	26.1	12.4						

[1]Price Index based on two-year average (2011-2012) prices for U.S. government grades.
[2]Numerical values ranging from 1-99 for flue-cured tobacco based on equivalent grades - higher the number, higher the grade.
[3] Average of 2008, 2011, and 2012.

Table 4. Disease Resistance of Selected Released Tobacco Varieties

Variety	Black Shank** Php gene (Race 0)	Black Shank** FL 301 (Race 1)	Granville Wilt	Nematode Resistance	Virus Resistance
CC 13		L	M	RKN (*M.j.*)	S
CC 27	Php	L	M	RKN TCN	TMV
CC 33		M	M	RKN (*M.j.*)	S
CC35	Php	M	L	RKN (*M.j.*)	S
CC37	Php	L	M	RKN (*M.j.*) TCN	TMV
CC 65		M	L	RKN (*M.j..*)	S
CC 67	Php	M	H	RKN TCN	TMV
CC 700	Php	M	L	RKN TCN	S
CC 1063		H	H	RKN	S
Coker 371 Gold	Php	L	M	S	S
GF 318	Php	M	M	RKN	TMV
GL 330		M	L	RKN	S
GL 338		M	M	-	S
GL 350		H	H	RES	S
GL 395		R	R	RKN	S
GL 737		M	M	RKN S	S
GL 939		M	R	R	S
GL 973	Php	H	L	S	S
K 149		M	H	RKN	S
K 326		L	M	RKN	S
K 346		H	M	RKN	S
K 358		L	M	RKN	S
K 394		M	L	S	S
K 399		H	H	RKN	S
K 730		L	M	RKN	S
McNair 944		M	L	S	S
NC 27 NF		L	H	RKN	S
NC 37 NF		L	H	RKN	S
NC 55		L	L	RKN	PVY, TEV
NC 60		H	M	RKN	S
NC 71	Php	L	L	RKN	S
NC 72	Php	L	M	RKN	S
NC 79		M	L	RKN	S
NC 92	Php	M	M	RKN	S
NC 95		L	H	RKN	S
NC 100		L	L	RKN	TMV& PVY
NC 102	Php	L	M	TCN & RKN	TMV/TEV/PVY
NC 196	Php	M	L	RKN	S
NC 291	Php	L	L	RKN	PVY, TEV
NC 297	Php	L	M	RKN	TMV
NC 299	Php	L	L	TCN & RKN	S
NC 471	Php	H	H	RKN	TMV

Table 4. Disease Resistance of Selected Released Tobacco Varieties. *(Continued)*

Variety	Black Shank** Php gene (Race 0)	Black Shank** FL 301 (Race 1)	Granville Wilt	Nematode	Virus Resistance
NC 567		L	L	RKN	TMV
NC 606		M	M-H	RKN	S
NC 810	Php	H	H	RKN	S
NC 2326		L	L	-	S
OX 940		M	M	S	S
OX 414NF		M	L	RKN	S
PVHO3		L	M	RKN	TMV
PVHO9		L	H	RKN	TMV
PVH 1118	Php	L	M	RKN	S
PVH 1452	Php	M	H	RKN/TCN	S
PVH 2110		L	M	RKN	S
PVH 2275	Php	L	L	RKN/TCN	PVY/TEV
RG 17		L	M	RKN	S
RG 22		M	M	RKN	S
RG 81		L	L	RKN	S
RGH 4		L	H	RKN	TMV
RGH 51	Php	L	L	RKN	S
RS 1410		M	M	RKN	S
Speight G-28		M	M	RKN	S
Speight G-70		M	M	RKN	S
Speight 102		M	L	RKN	S
Speight 168	Php	H	H	RKN	S
Speight 179	Php	M	H	RKN	S
Speight 190		M	H	RKN	S
Speight 210	Php	M	H	RKN	S
Speight 220	Php	M	H	RKN	S
Speight 225	Php	H	H	RKN	S
Speight 227	Php	H	H	RKN	S
Speight 234	Php	M	H	RKN	S
Speight 235		M	R	RKN	S
Speight 236		M	R	RKN	S
Speight-H20	Php	L	H	RKN	TMV
Speight-NF 3	Php	M	H	RKN	TMV
VA 116		L	L	S	S

**Black Shank Resistance Source:

Php gene provides complete resistance to Race 0. Growing these varieties WILL select Race 1. When black shank is seen on any Php variety refer to FL 301 resistance rating for best future option.

FL 301 resistance is a general resistance about equal to all known races of black shank. There is no FL 301 resistance high enough to be used without a Ridomil Gold program.

L=Low to no resistance; M=Moderate to fair resistance; H=High resistance; ? = unkown

Nematode RKN =resistance to Root Knot Nematode (races 1 & 3 of So. RKN unless noted) (*M.i.=M. incognita*, races 1 & 3), (*M.j.=M. javanica*), (*M.a.=M. arenaria*) TCN =resistance to Tobacco Cyst Nematode

Fusarium Wilt There appears to be a great variation among varieties to Fusarium wilt. However, we do not have sufficient data to make recommendations. Root-knot nematode resistant varieties may help in that root-knot tends to increase Fusarium wilt.

Table 5. Pedigree, Year of Release and Sponsor of Selected Varieties.

Variety	Yr of Release	Pedigree	Sponsor
NC 2326	1965	(HicksX9102)(Hicks)Hicks)Hicks)	NC
NC 92	2007	F1 Hybrid	NC
NC 95	1961	(C-139XBel.4-30)X(C-139XHicks)	NC
CC 13	2005	F1 Hybrid	CC
CC 27	2003	F1 Hybrid	CC
CC 33	2008	F1 Hybrid	CC
CC 35	2007	F1 Hybrid	CC
CC 37	2006	F1 Hybrid	CC
CC 65	2007	F1 Hybrid	CC
CC 67	2008	F1 Hybrid	CC
CC 700	2005	F1 Hybrid	CC
CC 1063	2011	F1 Hybrid	CC
Coker 371 Gold	1986	(G-28X354)X(CB139XF-105)(G-28X34)XNC82	GL
GF 318	2008	F1 Hybrid	GF
GL 330	2005	McNair 926 X 80241	GL
GL 338	2009	F1 Hybrid	GL
GL 395	2008	F1 Hybrid	GL
GL 350	2003	F1 Hybrid	GL
GL 737	1999	NC 1071 x Coker 319.	GL
GL 939	1992	McNair 92 X 80241	GL
GL 973	2000	F1 Hybrid	GL
K 149	1988	([G-28x354]x[CB-139xF-105]x[G-28X354])McNair 399	GL
K 326	1981	McNair 225(McNair30 X NC95)	GL
K 346	1988	McNair 926 X 80241	GL
K 358	1987	McNair 926 X 80241	GL
K 394	1983	Speight G-28 X McNair 944	GL
K 399	1979	(C-139 X C-319) X NC 95	GL
K 730	1989	(McNair 926 X 80241)	GL
NC 27 NF	1985	(C-319 X NC TG-21) X C-319	NC
NC 37 NF	1987	(C-319 X NC TG-21) X NC 82	NC
NC 55	1994	(K 326 X DH 1220) X (K 326 X Coker 371-Gold)	GL
NC 60	1985	McNair 944 X Speight G-28	NC
NC 71	1995	F1 Hybrid	RK
NC 72	1996	F1 Hybrid	RK
NC 100	1998	F1 Hybrid	NC
NC 102	2001	F1 Hybrid	RK
NC 196	2002	F1 Hybrid	GL
NC 291	1997	F1 Hybrid	CC
NC 606	1998	NC 729 X NC 82	NC
NC 810	2000	OX 2101 X NC 729	CC

Table 5. Pedigree, Year of Release and Sponsor of Selected Varieties. *(Continued)*

Variety	Yr of Release	Pedigree	Sponsor
NC 297	1998	F1 Hybrid	GL
NC 299	2001	F1 Hybrid	CC
NC 471	2003	F1 Hybrid	Raynor
OX 940	1992	(G-28 X Coker 347) X Coker 48	OX
OX 414NF	1997	NC 37 NF X K 346	OX
PVH O3	1998	F1 Hybrid	Profigen
PVH O9	1998	F1 Hybrid	Profigen
PVH 1118	2004	F1 Hybrid	Profigen
PVH 1452	2006	F1 Hybrid	Profigen
PVH 2110	2005	F1 Hybrid	Profigen
PVH 2275	2010	F1 Hybrid	Rickard
RG 17	1993	K 326 X K 399	Rickard
RG 22	1990	McNair 373 X Coker 51	Rickard
RG 81	1994	K 326 X K 399	Rickard
RGH 4	1994	Hybrid	Rickard
RGH 51	1998	F1 Hybrid	Rickard
RS 1410	1999	F1 Hybrid	Profigen
RX 116	2004	F1 Hybrid	Rickard
RX 123	2005	F1 Hybrid	Rickard
Speight 168	1996	Coker 371 Gold X Speight G-118	SPT
Speight 179	1997	C 371 G X SPG 28	SPT
Speight 190	1998	SP 116 X 346	SPT
Speight 210	2000	(SP 116 X G-126) (K 346 X G-28)	SPT
Speight 220	2002	(K 346 X SP 117) (SP 116 X K 346)	SPT
Speight-225	2003	(SP 168 X K 346) (SPA 95 X SP 168)	SPT
Speight-227	2003	(SP 151 X K 346) (SP 202 X K 346)	SPT
Speight-234	2004	(SP 168 X K 346)	SPT
Speight-235	2005	(SP 168 X SP 190) X (SP 197 X SP 178)	SPT
Speight 236	2005	(SP 168 X SP 196) X (SP 179 X SP 177)	SPT
Speight H-2O	1999	F1 Hybrid	SPT
Speight NF 3	1996	SP NF1 X NC 0007	SPT
VA 116	1989	NC 82 X C 319	GL

CC	Cross Creek Seed Company, Inc.	Reams	Reams Seed Company
CU	Clemson University	RG	R.G Seed Company
GL	Gold Leaf Seed Co.	Rickard	F. W. Rickard Seeds
NC	NC Agricultural Research Service	SPT	Speight Seed Farms, Inc.
OX	NCAgricultural Research Service (Oxford Station)	VA	Virginia Polytechnic Institute and State University
Raynor	Raynor Seed Company		

Table 6. Variety, Pedigree, Sponsor and Disease Resistance of the 2012 Released Variety Test (commercially available varieties), Roosevelt & Travis Dicks Farm, Columbia County, Florida. N 31o 30' 4.4" W 83o 31' 11.1"

Trt No	VARIETY	PEDIGREE	SPONSOR	Disease Resistance					
				BS	GW	FW	RK	BSp	Virus
1.	NC 71	F1 Hybrid	F.W. Rickard	H	R		R		
2.	CC 13	F1 Hybrid	Cross Creek Seed	R	R		MjR		
3.	NC 92	F1 Hybrid	F.W. Rickard	R	R		TCN /R		
4.	GF 318	F1 Hybrid	Raynor	R	R		R		
5.	CC 27	F1 Hybrid	Cross Creek Seed	R	R		TCN /R		TMV
6.	NC 196	F1 Hybrid	Gold Leaf Seed Co	R	L		R		
7.	PVH 1452	F1 Hybrid	F.W. Rickard	R	R		TCN /R		
8.	GL 338	F1 Hybrid	Gold Leaf Seed Co	R	R				
9.	NC 299	F1 Hybrid	Cross Creek Seed	R	R		TCN /R		
10.	K 326	McNair 225(McNair 30 X NC 95)	Gold Leaf Seed Co	L	L		R		
11.	CC 700	F1 Hybrid	Cross Creek Seed	R	R		TCN /R		
12.	GL 395	F1 Hybrid	Gold Leaf Seed Co	R	R		R		

[1]Resistance: H - High; M - Moderate; L - Low; R- Resistant; T - Tolerant; SU – Susceptible Diseases: BS - Black shank; GW - Granville Wilt; FW - Fusarium Wilt; RK - Root Knot; R1&3-*Meloidogyne Incognita* Race1 & Race3; Bn. Sp. - Brown spot; TMV - Tobacco Mosaic Virus; PVY - Potato Virus 'Y'; TSWV – Tomato Spotted Wilt Virus; TCN - Tobacco Cyst Nematode; TEV - Tobacco Etch Virus;

Sponsor: AOI-Alliance One; Clemson-Clemson University; CC-Cross Creek Seed Co; GL-Gold Leaf Seed Company; Gwynn Farms; NCSU-NC State University; RJR- RJ Reynolds Tobacco Company; Rickard-F.W. Rickard Seed Co; SPT-Speight Seed Farms; ULT-Universal Leaf Tobacco Co

Seeded: 1/29/12

Table 7. Yield, Grade Index, Price Index, and Value per Acre of the 2012Released Variety Test (commercially available varieties), Roosevelt & Travis Dicks Farm, Columbia County, Florida.

Trt	VARIETY	PEDIGREE		Yield	Grade Index	Price Index	Value
				lb/A	1-99	$/lb	$/A
1.	NC 71	F1 Hybrid	F.W. Rickard	2761	88.6	1.67	4617
2.	CC 13	F1 Hybrid	Cross Creek Seed	3190	88.4	1.67	5323
3.	NC 92	F1 Hybrid	F.W. Rickard	3220	89.2	1.68	5422
4.	GF 318	F1 Hybrid	Raynor	2862	86.0	1.62	4636
5.	CC 27	F1 Hybrid	Cross Creek Seed	3242	90.0	1.70	5511
6.	NC 196	F1 Hybrid	Gold Leaf Seed Co	3333	89.5	1.69	5631
7.	PVH 1452	F1 Hybrid	F.W. Rickard	2986	88.7	1.80	5377
8.	GL 338	F1 Hybrid	Gold Leaf Seed Co	3195	88.8	1.79	5723
9.	NC 299	F1 Hybrid	Cross Creek Seed	3180	88.8	1.81	5747
10.	K 326	McNair 225(McNair 30 X NC 95)	Gold Leaf Seed Co	3106	85.0	1.83	5683
11.	CC 700	F1 Hybrid	Cross Creek Seed	3243	89.1	1.80	5822
12.	GL 395	F1 Hybrid	Gold Leaf Seed Co	3186	85.0	1.83	5826

Grade Index is a numerical value ranging from 1-99 for flue-cured tobacco based on equivalent grades - the higher the number the higher the grade.

Price Index is based on a two year floating average (2011-2012) price for U. S. government grades.

PRODUCTION OF BARE ROOT TOBACCO TRANSPLANTS

J. Michael Moore, Paul E. Sumner, David C. Jones and Paul F. Bertrand

Producing quality bare root transplants in plant beds requires much effort and attention to detail on a daily basis. Following is an outline of management practices which has proven to be effective over the years. Attention should be given to each step.

PRODUCTION PROGRAM FOR BARE ROOT TRANSPLANTS

1. Plan to seed 80 to 100 square yards of conventional plant bed for each acre of tobacco to be transplanted. Growers with large acreage and those who have a high level of management may be able to produce sufficient transplants with less beds. Multiple clipping of plant beds along with excellent management may reduce the required yardage to less than 50 yards per acre.

2. Select a plant bed site with well drained soils, wind protection on the northeast side, a southern aspect and an irrigation source. To avoid black shank and tobacco mosaic virus problems do not locate beds in fields where tobacco was the previous crop. Methyl bromide will not control black shank. Prepare a good seed bed. Chop and incorporate any crop residue on the bed site early in the fall to allow ample time for decomposition before fumigation. Plant material may drag on the fumigation injectors causing uneven bed surface and poor fumigant distribution. The soil should be well tilled to a depth of 4 to 6 inches and free of clods.

3. Apply 3-6 lbs N/100 square yards. This nitrogen may be obtained from 50 to 100 lbs of 6-12-6 or 75 to 150 lbs of 4-9-3. Additional phosphorus and/or lime should be applied at this time if suggested by a soil test. Incorporate all fertilizer into the top 2 to 3 inches of soil.

4. Fumigate with 9 to 11 pounds of 98% methyl bromide, or 10 to 12 pounds of 68.6% methyl bromide per 100 square yards when soil moisture is good for cultivation and the air temperature is above 55°F. Since no herbicides are available for use in plant beds, a good job of fumigation is very important. Fumigated soil should not be disturbed deeper than 2 to 3 inches to eliminate the risk of bringing up untreated weed seeds and nematodes.

5. Perforate plastic with 1/4 inch holes, 2 inches apart, before removing from the bed prior to seeding.

6. Beds should be seeded 60 to 65 days before the desired transplanting date if perforated plastic is to be used as the exclusive bed cover. Beds seeded too early may germinate early and be damaged by winter freezes. Broadcast 1/6 to 1/8 ounce of raw uncoated seed or less per 100 square yards. For coated seed aim for a final stand of 30,000 to 40,000 harvestable plants per 100 square yards. When calculating seeding rate account for the germination rate of the seed with additional reductions for losses due to weather, insects and disease.

7. Ridomil is no longer labeled for application to seed beds for protection against blue mold and damping-off (caused by *Pythium* sp.). Use of Ridomil in seed beds may increase the potential for accumlation and spread of Ridomil insensitive (resistant) forms of blue mold and may actually result in greater injury to field production.

8. Apply a thin layer of fumigated wheat or clean pine straw to hold the cover off young plants. Approximately 15 to 20 lbs of straw per 100 square yards of bed space is sufficient. An alternative is to use a roller/packer to firm the bed surface and form small ridges approximately one and a half to two inches high. These ridges will hold the cover up off the newly germinated plants avoiding damage from the movement of the plastic by the wind.

9. Irrigate beds to wet the soil 6 to 8 inches deep (one half inch of irrigation) just after seeding but before covering with plastic. Providing adequate soil moisture is of greater importance when coated seed are planted and when large areas are seeded such as is the case with commercial plant production. Adequate moisture must be supplied for coated seed to absorb enough moisture over a short time period to allow for successful germination of a high percentage of the seed. Small irrigation gun orifices and high pressure should be used when irrigating seeded beds in order to provide small droplets which will not cause seed to be washed or covered by washing soil.

10. Cover beds seeded with raw seed tightly with perforated plastic or other covers immediately after irrigation. Solid plastic can act like a greenhouse and accumulate heat with no opportunity for ventilation. However, beds seeded with coated seed often benefit from being covered at first with non-perforated covers until the seed have germinated. Water which funnels through the perforations in the plastic will float coated seeds along the press wheel track and pile seeds at the lower end of the bed. Care should be taken to monitor temperatures under the cover until germination occurs and the plastic can be perforated.

    Excessively high or low temperatures will cause damage to seed or young plants. Seed germination uniformity may be reduced by temperatures in excess of 80° F when these temperatures are experienced prior to germination. Temperatures in excess of 100° F can reduce seed viability resulting in a reduced plant stand. Tight covers will minimize plant damage from wind blown covers.

11. Check beds daily for problems with soil moisture, loose covers, insects, disease, or high temperatures.

12. Remove perforated plastic when daily temperatures reach 75°F for 2 consecutive days. Replace if temperatures are expected to drop below 45°F.

13. Begin regular clipping when plants are approximately four inches from the soil line to the bud. Plan to clip three to four times, approximately one half inch above the bud to improve uniformity. Additional clippings may be required for slow growing plants or beds which are of poor uniformity.

14. Undercutting well managed, uniform beds prior to pulling can significantly reduce labor costs by making pulling easier. Caution should be used to avoid root injury due to shallow undercutting. Undercutting beds which are of poor uniformity may result in pulling plants of assorted sizes. Small plants will have to be sorted out as they may not survive transplant shock.

PLANT BED PROBLEMS

Production of healthy transplants is the first step toward a successful and profitable crop. Poor quality transplants may cause a variety of early-season problems and may predispose the plants to season-long problems accentuated by disease and/or weather resulting in lower yields and leaf quality. Costs of production are increased by beds with poor stands, plants damaged by improper fertilization inadequate cover management, poor moisture management, and replanting fields with poor stands. Adequate, but not excessive moisture is a must to insure timely seed germination and proper growth of young transplants. Drainage, cover management, and irrigation all play a part in moisture management.

DRAINAGE

Locate beds in sites with good surface and internal drainage. Crown or raise beds to provide for natural removal of excess water. Install ditches or drains around beds to remove standing water. To avoid water soaked spots in beds the plastic tarp should remain covered until time for seeding. Rake or shape beds if necessary prior to

seeding to remove low or uneven areas. Large amounts of water do not normally penetrate perforated plastic covers, but beds should be checked closely for wet spots after prolonged rainfall.

COVER MANAGEMENT

Perforated plastic covers are used by a majority of tobacco transplant growers in Georgia. Plastic used for covering fumigated beds is perforated by punching out 1/4 inch holes every two inches. Perforated plastic may eliminate the need for purchasing an additional cover for the beds. Plant growth may be more consistent and transplanting date more accurately predicted with plastic than with some synthetic or woven covers.

After germination, remove plastic covers from beds when air temperatures under the plastic reach 100°F before the plants reach the size of a quarter. Older plants may tolerate temperatures up to 110-115°F for short periods of time depending on existing humidity under the plastic. As a rule-of-thumb plastic covers should be removed after outside temperatures have reached 75°F for two consecutive days and replaced when temperatures are expected to drop below 45°F. A thermometer placed so that it may be read through the plastic provides a sure way of monitoring temperatures under the plastic. Transplant producers who have large numbers of beds, other farm enterprises, off-farm employment, or other time restraints may have difficulty properly managing perforated plastic covers.

Some growers choose to replace perforated plastic with synthetic or woven covers as the daily temperatures increase. Advantages of these covers include improved ventilation, no build up of radiant heat, and increased infiltration of rainfall or irrigation. Spray applications may be made without removing these covers. Covers need only be removed to provide access for clipping. Beds covered with synthetic covers have a tendancy to dry out in advance of plastic covered beds and need additional monitoring and irrigation.

IRRIGATION

Plant beds should be irrigated following seeding to settle the seed and provide good seed to soil contact. Soil should be wet six to eight inches deep (1/2 to 3/4 inches of irrigation) before covering with plastic covers. Leaving the beds uncovered until it rains is risky as heavy rainfall may puddle seeds and result in poor plant distribution or washed out beds.

PLANT BED FERTILIZATION

Tobacco seedlings require relatively high amounts of nutrients to insure the rapid growth desired for transplanting. However, the temptation to over fertilize plant beds should be strongly avoided. Excessive rates of N and K fertilizers can decrease stands and damage young growth. Heavy N applications can cause plants to become too tender and succulent, and require more frequent clipping. Excessive succulent growth can increase the potential for disease under the plant canopy. Tender plants may be damaged when pulled and transplanted. Tender plants can be more easily damaged by sun scalding or by blowing sand once transplanted.

Select sites for plant beds early in the fall. Have the soil tested for lime and fertilizer requirements. Be sure to identify the crop as a "tobacco plant bed". Apply needed lime as early as possible to allow sufficient time to react with the soil.

Apply a complete tobacco plant bed fertilizer that will supply at least 3 and no more than 6 pounds of N per 100 square yards. This may be obtained with 50 to 100 pounds of 6-12-6 per 100 square yards (2400 to 4800 pounds of fertilizer per acre). Use lower rate with plastic covers. Mix fertilizer with the upper 2-4 inches of soil prior to seeding. Irrigate to wet soil to a depth of 6 to 8 inches (1/2 inch of irrigation) after seeding but before covering to prevent fertilizer salt injury and promote uniform germination. Since much of the growth will occur in cool soils which have been fumigated, at least 50% of the applied N should be in the nitrate form.

NITROGEN SOURCE

Mineral sources of fertilizers usually provide more consistent results than organic sources. Organic sources can encourage buildup of some insect pests, and can provide a favorable environment for damping-off diseases, both of which reduce the stand. Natural organic materials have however, been touted as slow release forms of N that will continue to provide N over a long period of time, and offer protection against leaching.

Studies with these materials indeed show an initial slow availability of organic N; it takes about three to four weeks for unusable organic N to convert to inorganic forms which the plant can use. Of the organic N which becomes available over a 90 day period (about 30-50% of the total N) , essentially all is converted during these first few weeks. Thus little protection against leaching results. The uncertainty of this conversion process, and the variability of natural organic compounds further complicate use of these materials. In view of the disadvantages and additional costs of organic sources, mineral sources of fertilizers are strongly recommended for plant beds.

YELLOW PLANTS

Excessive rainfall can leach nutrients out of the root zone, resulting in yellow, nutrient deficient plants. Tissue analysis is the only sure way to know the cause of the yellowing, but leaf symptoms can sometimes provide a clue. If the plants show yellowing of leaves and stems on the lowest leaves first, the problem is usually N deficiency. Additional nitrate-N may be applied once plants are dime-sized to maintain desired color and promote rapid growth. Limit application to 0.5 to 1 pound nitrate nitrogen (3 to 6 pounds of nitrate of soda or calcium nitrate) per 100 square yards which is equivalent to 25 to 50 pounds of N (150 to 300 pounds nitrate of soda or calcium nitrate) per acre. If color does not improve within a few days, N deficiency is not the problem. If the whole plant is yellow, sulfur may be deficient, and extra N will not correct the problem. Magnesium deficiency symptoms are similar to those of nitrogen in that the lower leaves turn yellow first; however, the veins of Mg-deficient plants remain green. Magnesium and sulfur deficiencies may be corrected by applying potassium-magnesium-sulfate (K-Mag or Sul-Po-Mag) at a rate of 3 pounds per 100 square yards (150 pounds per acre) or Epsom Salts at a rate of 5 pounds per 100 square yards (250 pounds per acre).

Do not apply fertilizers to wet foliage. Irrigate after application to wash fertilizer material off the leaves. Pelletized materials are less likely to cause leaf burn, but are somewhat slower to dissolve than pulverized materials. When applied properly, either source should be safe and effective.

TOBACCO MOSAIC VIRUS (TMV)

TMV is spread mechanically by handling plants, cultivation, etc. It is favored by excess nitrogen. Symptoms can be quite variable and often disappear in mid Summer. Control is achieved through crop rotation, root and stalk destruction, and careful handling during transplanting as outlined below.

a) Rinse hands with milk prior to each plant handling operation.
b) Do not handle tobacco products or weeds around plant beds during or prior to handling plants.
c) The following varieties could be used where TMV is a major concern: NC 297 or Speight G H20.
d) See section on clipping for mower sanitation instructions.

NOTE: These precautions are important. TMV may not show up until after transplanting at which time precautions are too late. As soon as possible after completion of transplanting, destroy the plant beds.

Table 1. Plant bed Fumigation and Disease Control

CHEMICAL AND FORMULATION	RATE	REMARKS AND PRECAUTIONS
Weeds and Nematodes		
Methyl Bromide 98%	9 lbs/100 sq yd	APPLY METHYL BROMIDE WHEN SOIL TEMPERATURE IS ABOVE 50°F. Cans: Release gas under plastic covering. Plastic should be raised in the center and sealed around the edges with soil. Leave covered 24 hours. Remove cover 72 hours prior to seeding.
Methyl Bromide 68.6%	10-12 lb/100 sq yd	Cylinders: Inject into well prepared soil with chisel applicators. Cover immediately with plastic and seal all edges. Leave covered for 48 hours. Remove cover 72 hours prior to seeding.
Vapam	37.5 gal	A. Spray Vapam on soil surface, incorporate 6" deep with tiller, and cover with plastic tarp all in a single operation as is done with Methyl Bromide. B. After treatment wait 7 days before punching plastic. C. After punching plastic wait 7-14 days before seeding.
Vapam + Telone C-17	37.5 gal + 10 gal	A. Spray Vapam on soil surface, chisel in Telone C-17, incorporate/seal by tiller (6" deep) behind chisels, and cover with plastic all in a single operation as with Methyl Bromide. B. After Treatment wait 7 days before punching plastic. C. After punching wait 14-21 days before seeding
Blue Mold , Pythium Damping-Off, Rhizoctonia Damping-Off and Target Spot		
Dithane DF	1.4-2.4 lb/Acre (0.7-1.2 oz./150 sq yd)	Use as an over the top spray and continue on a 7-day schedule as long as conditions warrant. Spray after clipping.
DO NOT USE ACROBAT MZ or FORUM IN PLANT BEDS OR GREENHOUSES.		

TOBACCO PLANT BED INSECT CONTROL

Insects can cause severe damage in tobacco plant beds. The most common pests in tobacco plant beds are vegetable weevils, tobacco flea beetles, cutworms, and mole crickets. Vegetable weevil larvae chew small irregular holes in the leaves and often feed in the buds and on the stems. Tobacco flea beetles feed on the leaves, leaving numerous small punctures. Cutworms eat small half circles in the leaf margins and cut young plants off near the soil surface. Mole crickets burrow in the upper 2 inches of soil and feed on the roots and stems of plants, uprooting them.

Other pests which cause occasional problems include green June beetle larvae, slugs and snails, aphids, and tobacco budworms. Aphids and tobacco budworms, carried from the plant bed on transplants, can start early infestations in the field. Plant beds should be checked once or twice each week for insects and their damage. Recognition of the insects present, their abundance, and their damage is essential in deciding whether or not to use an insecticide. Recommended insecticides for use on tobacco plant beds are listed in Table 2.

Table 2. Plant Bed Insect Control

INSECT	CHEMICAL AND FORMULATION [1]	RATE PER 100 SQ. YDS.	REMARKS AND PRECAUTIONS
Aphids (preventive control)	disulfoton (Di-Syston 15G)	9 ozs	Apply granules broadcast just before seeding or over top of small plants - water in immediately. Do not exceed recommended rate.
Aphids, Flea Beetles or Vegetable Weevils	acephate (Orthene 75S) (Acephate 75SP) (Orthene 97PE)	1 tbsp in 1 gal water (1 lb/Acre) 0.75 tbsp in 1 gal water (12 oz/Acre)	Apply to foliage as needed
Budworms	acephate (Orthene 75S) (Acephate 75SP) (Orthene 97PE)	1 tbsp in 1 gal water (1 lb/Acre) 0.75 tbsp in 1 gal water (12 oz/Acre)	Apply to foliage as needed.
Cutworms	acephate (Orthene 75S) (Acephate 75SP) (Orthene 97PE) carbaryl (Sevin 5%B)	1 tbsp in 1 gal water (1 lb/Acre) 0.75 tbsp in 1 gal water (12 oz/Acre) 0.5-1 lb	Apply to foliage in late afternoon or at dusk. Scatter bait evenly at dusk around margins, walkways and open spaces in bed. Keep off plants as much as possible.
Green June Beetle Grubs	carbaryl (Sevin XLR Plus)	5.5 oz. in 50 to 100 gals water	Apply only to uprooted areas of bed.
Mole Crickets	Acephate and carbaryl 5%B as applied for cutworms gives helpful control.		See remarks under cutworms.
Slugs and Snails	Metaldehyde 5%B	4 - 13 ozs.	Scatter bait evenly at dusk around margins, walkways and open spaces in bed. Don't apply directly to plants.

PLANT BED MECHANIZATION

Direct seeding tobacco plant beds has become popular in recent years. Some facts should be noted before one considers direct seeding tobacco beds.

BED PREPARATION

The tobacco bed area should be prepared and fertilized normally. Prior to seeding, the bed area should be worked lightly to provide a firm seedbed. Make sure that the press wheel of the planter makes a $^1/_2$ to 1 inch depression in the bed at seeding. This will cause the plastic cover to rest on the soil, not on germinated seeds. Coated seed must be placed in direct contact with the soil. A concerted effort should be made to interface the soil and seed as much as possible. The seeded bed should be irrigated as normal. Care should be taken not to used large volume sprinklers. Use a combination of high pressure and small nozzle opening in the sprinkler head to produce small water droplets.

PLANTER OR SEEDER

The type of planter to use is one that will drop seed at a uniform rate. Commercial plant growers are using the belt or vacuum type planters.

SEED SPACING

Seed should be spaced 1/2" to 13/16" apart resulting in approximately 35 to 45 seed per square foot of bed. At this seeding rate the estimated plant population for a 100 square yard bed is 30,000 to 40,000 plants.

CLIPPING TOBACCO PLANT BEDS

Tobacco seedlings produced in traditional plant beds vary greatly in size and suitability for transplanting. Because of plant variability, only 10 to 20 percent of the total seedlings in the plant bed are available for transplanting in any one pulling. Tobacco growers often adjust to this shortage in plant availability by allowing more plant bed yardage per acre of transplanted tobacco or by transplanting fewer acres per day. Clipping seedlings increases the uniformity of seedling-height.

FIELD PERFORMANCE OF CLIPPED PLANTS

Studies in North Carolina have been conducted comparing the field performance of plants from clipped and non-clipped plant beds. These studies were conducted over several years at research stations and on-farm tests. Results from the research station experiments showed that yield from clipped plants was equal to and, in some cases, higher than plants from non-clipped plant beds. On-farm tests show similar results.

CLIPPING PROCEDURE

A high-suction lawn or tractor mounted mower may be adjusted to clip at a height just above the buds of the largest plants. This removes portions of the larger leaves from the largest plants and allows sunlight to reach the smaller plants. Growth of the clipped plants is reduced, and the smaller, non-clipped plants can then catch up with the larger ones.

To get the maximum benefit from clipping, mowing should begin when the tips of the buds of plants are approximately four inches from the soil line. Use a ruler to measure the height to the tip of the bud of the largest plants, and adjust the mower to one-half to one inch above that height. Some additional adjustments may be

needed if the soil is wet. After the mower height has been adjusted, mow across the plant bed to be sure the clipping height stays above the buds.

If plant bed middles have been raised or crested to shed water, it is best to start mowing to the immediate left or right of the center. If the mower straddles the center of the raised bed seedlings located on the crest may be clipped too low.

Sanitation is particularly important, if the mower is also used for general purpose mowing in which case it may come in contact with weeds such as horse nettle which serves as an alternative host for tobacco mosaic virus.

HARVESTING

Harvest can be accomplished by hand pulling or utilizing a plant bed undercutter. An undercutter has been used by vegetable growers for many years. It consists of a long, flat, steel blade mounted on each end to a frame. Once undercut, plants can be harvested easily by hand.

BED CLIPPING PRACTICES IN RELATION TO SEEDLING DISEASES

There have not been any disease problems associated with clipping plant beds. There are two practices which will help minimize chances of future disease problems.

1. Removal of clippings from the beds is less favorable for damping-off diseases than allowing them to accumulate on the beds. We would not expect any problems from clippings unless massive quantities accumulated on beds creating a mulching effect.

2. Tobacco mosaic virus (TMV) can be spread very easily by any handling operations. An operation such as clipping can spread TMV throughout a plant bed.

    a) Hazards of spreading TMV from outside sources during clipping beds can be prevented by mower sanitation. Any mower that is used to mow weeds around beds should be cleaned before clipping beds. Many weeds such as horsenettle carry TMV. Any mower that is shared among growers or used to clip other plant beds including tomatoes or peppers should be cleaned before use in tobacco beds. Mower cleaning is very simple.
        1) Clean all plant residue off the mower.
        2) Wash the mower using a brush or rag with a solution of chlorine bleach (50% water & 50% household bleach).
        3) Rinse with clean water.

    b) If TMV is found in a bed DO NOT clip this bed. No amount of mower sanitation can prevent spread of TMV, if infected plants are in the bed.

TRANSPLANT PRODUCTION IN THE FLOAT SYSTEM

W. David Smith, Loren R. Fisher and Matthew Vann - NCSU
J. Michael Moore, Paul Bertrand David Jones and Paul E. Sumner, University of Georgia

To produce high-quality tobacco, growers must begin with healthy transplants. An ideal transplant is disease free, hardy enough to survive transplanting shock, and available for transplanting on time. In general, early transplanted tobacco yields more than late-transplanted tobacco. The historical last-frost date for a region is a good guideline for selecting a date for setting out transplants, but the five-day weather forecast is better. In general, tobacco that has been transplanted for several days can tolerate frost better than recently transplanted tobacco.

The greenhouse float-system method produces excellent quality transplants with uniform stem lengths in a very predictable time period. However, the weather does affect production in the greenhouse. For example, cool, cloudy conditions can delay germination. Unseasonably warm temperatures in February and March can increase the rate of plant growth, causing problems with stem and root diseases, particularly if the seeds are planted in the greenhouse too early. Successful transplant production in a greenhouse requires intensive management with great attention to details. Little problems can become big problems very quickly.

Transplant production costs per acre increase when the percentage of usable transplants decreases. Therefore, management practices that improve stands and promote uniform growth decrease production costs. Nearly all management practices affect usability, but these are some of the most important:

1. Consider the materials.
   - Analyze the water source and manage alkalinity.
   - Select a uniform, high-quality growing medium with a low and well-mixed nutrient charge.
   - Consider tray design.
   - Use seeds with high germination rates and acceptable pelleting materials.

2. Promote uniform emergence.
   - Sow seeds during sunny periods.
   - Fill trays uniformly.
   - Place seeds uniformly (in the center of the dibble).
   - Provide a warm temperature (68 to 70°F at night).
   - Reduce spiral rooting.
   - Control ants and mice.

3. Promote uniform growth.
   - Monitor fertilizer salts in the medium and leach with water from overhead when necessary.
   - Continue to analyze water and manage alkalinity when necessary.
   - Clip properly.
   - Manage insects and diseases.

4. Prevent stand loss.
   - Provide proper ventilation and airflow to prevent heat injury.
   - Avoid early seeding, high nitrogen rates, and hot daytime temperatures that promote stem rot diseases.
   - Fumigate trays with methyl bromide or purchase new trays.

Analyze the Water Source and Manage Alkalinity

Water quality management is an important part of successful transplant production. Bicarbonate levels (alkalinity) are high in water from many areas, particularly in eastern counties. counties, primarily in Eastern North Carolina. Excessive boron levels have occasionally been found in water samples from the east, and boron deficiencies have been observed on seedlings in float systems from the piedmont. Sodium is occasionally high, which can cause salt problems for overhead-irrigated systems, although recent research has shown tobacco seedlings in float systems to be very tolerant to sodium. Surface water should be avoided because of potential disease problems.

The three most important water quality parameters for most growers are: pH, soluble salts (conductivity), and alkalinity or total carbonates. A low pH (5.0 to 6.0) indicates an acidic condition and a fertilizer that will raise the pH should be used. A higher pH (greater than 7.5) will generally indicate high alkalinity levels (high carbonates). Acidifying fertilizers that lower the pH and neutralize alkalinity should be used. Remedies fo high alkalinity will depend on the severity. Alkalinity levels of 100-200 ppm would correspond to total carbonate levels of 2-4 meq and would not be expected to cause substantial growth problems. Corrective action in this case would only involve the use of an acidifying fertilizer such as the Peters Excel 15-5-15. Alkalinity levels of 200+ and carbonate levels of 4+ call for corrective action such as the addition of calculated amounts of acid.

Analysis: The University of Georgia Agricultural Services Laboratories provides water analysis for pH and Basic Cations (P, K, Ca, Mg, Mn, Fe, Al, B, Cu, Zn, Na, Cr, Cd, Ni, and Mo) at a cost of $10.00 per sample (Soil, Plant and Water Laboratory, 2400 College Station Road, Athens, GA 30602, Phone: (706) 542-5350. Analysis for Alkalinity (the total bicarbonate content) of the water is performed for $12.00 per sample (Feed and Environmental Water Laboratory, 2300 College Station Road, Athens, GA 30602, Phone: (706) 542-7690. Results for alkalinity are reported in parts per million (ppm).

A 16-ounce sample should be collected from each potential water source and for each analysis requested. A clean, nonreturnable drink bottle with a screw-on cap is an excellent sample bottle. Rinse the bottle (but do not use soap) several times before collecting the sample, and allow the water to run several minutes before collecting the sample. Fill the bottle completely so that no air remains. Forms and assistance are available from county Extension offices. Sample reports should be requested to be sent to the local County Extension Agent and to the Extension Agronomist - Tobacco. Recommendations related to the nutritional suitability of the water for transplant production will be discussed and forwarded by the local agent.

Wells are the most desirable water sources. Municipal sources that have been treated and filtered also are satisfactory. Pond or river water usually is suitable nutritionally. However, black shank has been observed on seedlings in float-systems filled with pond water in Kentucky. The potential for water contamination with soil-borne pathogens also exists for tobacco in North Carolina. Herbicides that injure tobacco also could be carried in soil runoff into ponds. Therefore, most (if not all), surface water sources should be avoided.

Select a High-Quality Growing Medium

Typical tobacco media consist primarily of peat combined with vermiculite and perlite in various proportions. Consider a medium's particle size distribution and nutrient charge to determine its suitability for transplant production. Particle size in a soil-less medium is similar to soil texture and is determined by the relative amounts and size of the mix's components. The particle size distribution of a medium determines many characteristics that are important in plant growth, such as aeration, water holding capacity, drainage, and capillarity (wicking).

Research has shown that a wide range of particle sizes is suitable. After you find a medium with a good range of particle sizes for tobacco production, make sure that it is free of sticks, stems, clods, and weed seeds. Evaluate its moisture content, uniformity, and fertilizer charge.

Consider Tray Design

Researchers continue to investigate tray design in relationship to production costs and disease management. A significant factor affecting tray cost to the grower is the cost of fuel. High natural gas prices have increased the cost of manufacturing, while high fuel prices have increased the cost of transportation and delivery.

Tray costs have always been an issue outside the United States because of shipping costs. Polystyrene trays are light, but they are bulky, which makes them expensive to ship. The high cost of growing medium is also a factor overseas. One way to reduce production and shipping costs is to decrease the depth of the tray, which allows more trays to be placed in a shipping container or on a truck. Shallower trays have the additional advantage of requiring less growing medium to fill the cell, which decreases the cost to a grower. Less on-farm storage space is required for shallow trays than for traditional-depth trays.

Recently a glazed tray was introduced that has hardened sidewalls within the cell, which are formed by superheating during the manufacturing process. The idea is that the hardened sidewalls will resist root penetration and be easier to sanitize. However, the tray depth is slightly shallower than a traditional 288-cell tray. This difference in depth results in slightly smaller cells (15 cubic centimeters versus 17 to 17.5 cubic centimeters), which partially offsets the cost of glazing and decreases growing medium requirements by 12 percent. Observations suggest that fewer roots penetrate the tray, but research has not been conducted to determine if disease incidence is different with plants produced in glazed trays versus those produced in traditional trays.

Studies conducted in 2004 and 2005 measured the effects of cell density and volume on transplant production (Tables 4-1 and 4-2). Researchers compared four trays differing in cell density and volume filled with three different growing media. They compared the he following trays:

1. A glazed 288-cell tray with a cell volume of 15 cubic centimeters and cell density of 122.5 cells per square foot in 2004 and a traditional 288-cell tray with a cell volume of 18 cubic centimeters and cell density of 122.5 cells per square foot in 2005.
2. A shallow, glazed 288-cell tray with a cell volume of 8.6 cubic centimeters and cell density of 122.5 cells per square foot.
3. A traditional 200-cell tray with a cell volume of 27 cubic centimeters and cell density of 85 cells per square foot.
4. A shallow 200-cell tray with a cell volume of 8.6 cubic centimeters and a cell density of 85 cells per square foot.

Results indicate that 200-cell trays produced larger plants than 288-cell trays. However, there were no differences in plant size due to tray depth. Thus, in a float system, cell density is more important than cell depth (root volume) in affecting plant size. These results indicate that shallow trays can be used without reducing transplant quality. There were minor differences in usability among media in 2005. However, there were no interactions between media and tray type in 2004 or 2005. Thus, all of these media would be suitable for shallow trays.

Table 4-1. Effect of Cell Volume and Density on Transplant Production in the Float System, 2004

Treatment	ISM[1] (%)	Spiral Root (%)	Total Plants (%)	Usable Plants (%)	Stem Length (cm)	Stem Diameter (mm)
Trays						
Glazed 288 Traditional (15 cc per cell)	95	3	94	88	6.4	3.0
Glazed 288 Shallow (8.6 cc per cell)	96	4	92	84	6.3	3.0
200 Traditional (27 cc per cell)	96	3	95	90	7.0	3.6
200 Shallow (8.6 cc per cell)	95	3	94	87	7.0	3.8
LSD (0.05)	**NS**	**NS**	**NS**	4	0.3	0.3
Growing Medium						
Carolina Gold	95	3	94	87	6.6	3.3
Carolina Choice	96	4	94	88	6.5	3.4
All Peat, Aggregate Free - Experimental	96	4	93	86	6..8	3.3
LSD (0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

[1]ISM = Modified Index of Synchrony which is a measure of the germination that occurred over a 48-hour period.
NS = Not statistically significant. similar. Treatments should be considered similar.

Table 4-2. Effect of Cell Volume and Density on Transplant Production in the Float System, 2005

Treatment	Emergence (%)	Total Plants (%)	Usable Plants (%)	Stem Length (cm)	Stem Diameter (mm)
Trays					
Glazed 288 Traditional (15 cc per cell)	94	90	79	4.9	2.5
Glazed 288 Shallow (8.6 cc per cell)	96	91	81	5.9	2.4
200 Traditional (27 cc per cell)	94	91	84	6.2	2.9
200 Shallow (8.6 cc per cell)	94	92	84	6.1	2.9
LSD (0.05)	2	NS	NS	0.4	0.3
Growing Medium					
Carolina Gold	93	87	78	5.7	2.6
Carolina Choice	95	93	84	5.8	2.6
All Peat, Aggregate Free - Experimental	95	93	84	5.9	2.7
LSD (0.05)	2	5	4	NS	NS

NS = Not statistically significant. similar. Treatments should be considered similar.

Promote Uniform Emergence

Uniform emergence and growth are necessary to produce a high percentage of usable transplants. Research conducted in 1999 and 2000 showed that even a three-day delay in emergence in 25 percent of the seedlings could reduce usability (Table 4-3). The researchers seeded random cells within a tray 3, 5, 7, or 12 days after seeding the rest of the tray. In general, the delayed treatments produced fewer usable seedlings than the initial seeding. These results show the importance of uniform emergence and that clipping will not correct the uneven growth from delayed emergence.

Table 4-3. Effect of Staggered Seedling Emergence on Transplant Production, 1999-2000

Treatment	Total Stand at Day 50	Usable Transplants at Day 50
1999 Experiment	-%-	-%-
Check (100% seeded day 1)	89 a	76 a
75% seeded day 1, 25% seeded day 5	89 a	59 b
75% seeded day 1, 25% seeded day 7	90 a	66 ab
75% seeded day 1, 25% seeded day 12	80 b	65 ab
2000 Experiment		
Check (100% seeded day 1)	95 a	91 a
75% seeded day 1, 25% seeded day 3	96 a	85 b
75% seeded day 1, 25% seeded day 5	97 a	78 c

Note: For each experiment, averages followed by the same letter in a column are not statistically different and should be considered similar.

Fill and Seed Trays Uniformly

Begin seeding 50 to 55 days before the anticipated transplanting date using only high-quality, pelleted seeds. Make sure that one seed is placed in each cell. Misting trays from overtop after floating has not been shown to speed seedling emergence. However, the use of a premoistened medium decreases the amount of medium that falls through the holes in the bottom of the tray and increases the speed of emergence as compared to a dry medium. Overly wet media do not flow from the hopper box as uniformly as dry media. Be sure the trays are filled uniformly.

Wet new trays before filling them, and screen the planting medium if it contains sticks and clods. Use a moist medium, and pack the medium all the way to the bottom of the cell. Research indicates that taking these precautions will help to prevent dry cells within a tray.Dry cells create a common problem in float systems, particularly with new trays, because they float higher than old trays and because it is difficult to keep the medium from falling through the hole in the bottom of the tray.

Manage Spiral Rooting

Spiral roots (aerial roots) can cause significant stand losses. In general, the reduction in the number of usable transplants is about one-half of the percentage of spiral rooting. For example, if 10 percent of the cells in a tray

contain spiral roots, a grower can expect the number of usable transplants to be be reduced by 5 percent. Some of the conditions that may induce spiral rooting can occur when seeds are sown.

Causes of spiral rooting. Researchers have found that spiral rooting results from complex interactions among the variety sown, pelleting material, growing medium, and environment. For example, differences in spiral rooting among varieties are common. We do not know if these differences are genetic, a coincidence involving the time of germination and an environment favorable for spiral root development, the seed pelleting material, or some combination of these factors. Tests have shown differences in spiral rooting when different companies coated the same seed lot of one variety. Differences in spiral rooting have also been observed when the same company coated seeds of the same variety. The greenhouse environment is also a factor. We commonly see differences in spiral rooting levels when tests with the same seed and growing medium are conducted by specialists in Virginia, North Carolina, and South Carolina.

Differences in spiral root incidence have also been observed between brands of growing medium. However, a brand of growing medium may cause more spiral roots than others one year, but not the next.

Recent observations suggest that pellets harden after repeated cycles of drying and rewetting, similar to the conditions that occur when temperature and humidity in the greenhouse change from day to night. The hard pellet then becomes a barrier between an emerging root and the growing medium, preventing normal root penetration. Research in North Carolina that has found increased spiral rooting under hot and sunny conditions supports these observations. Thus, spiral roots may occur when the greenhouse environment contributes to the growing medium being too wet, as well as when the surface of the medium is too dry. Therefore, seeding date will not consistently reduce spiral rooting because the set of known "good" environmental conditions is too narrow.

Primed seeds. Priming is a seed treatment that begins the germination process in a seed company's laboratory. After the early stages of germination occur from exposure to warm temperature, darkness, water, and then light, the seeds are dried. This treatment produces seeds that are at the same stage of germination when purchased by the grower, and seedlings emerge quickly and uniformly. However, research has shown that priming sometimes improves the *rate* of seedling emergence (by one to two days) but seldom improves the *uniformity* of emergence. There is also considerable variation in priming response among varieties tested and among seed lots within a variety. Therefore, the decision to prime seeds should be made by the seed company, based on pretesting of individual seed lots, rather than by the grower (unless the grower intends to cover seeds with growing medium to prevent spiral rooting).

Provide a Warm Temperature

The ideal germination temperature for tobacco seeds is approximately 68°F at night and 86°F during the day. Fuel use decreases 15 percent for every 5-degree reduction in temperature. Therefore, after maximum seedling emergence is obtained, nighttime temperatures should be reduced to a range of 55 to 60°F to conserve fuel usage. Daytime temperatures of 80 to 85°F are adequate for normal growth. Heat injury (browning of leaves or seedling death) has been observed when air temperatures inside the structure exceed 110°F.

Different varieties respond in various ways to germination temperature, and it is very common to see differences in germination rate among varieties in the same greenhouse. The response of four popular varieties to temperature during germination is shown in Figures 4-1 through 4-8. In all varieties the germination was earlier at 68°F night and 86°F day than at 68°F night and 95°F day. However, the delay in germination from high temperatures differed greatly among varieties and, in some cases, between seed lots within a variety. These data show that higher than ideal temperatures, even as low as a 95°F day, can delay emergence, reduce uniformity of emergence, and sometimes even decrease total emergence. For a variety such as K 326, the delay in emergence at high tempreatures is relatively small (Figures 4-1 and 4-2). However, for NC 71 (Figures 4-3 and 4-4) and NC 297 (Figures 4-7 and 4-8), the delay in germination is significant. It is important to remember that these studies were conducted in an

incubator. Response to high temperature stress in a greenhouse will be greater because delayed germination makes the plants more susceptible to salt injury and disease.

While research has shown 68°F night and 86°F day to be the most favorable temperatures for germination in all tested varieties, it is very common to observe a range of germination times among varieties. Studies conducted with seed from the 2003 Official Variety Test found that most varieties reached maximum germination in 7 to 8 days when exposed to ideal temperatures of 68°F night and 86°F day. However, the range among varieties was from 6 to 13 days. The germination of most varieties was delayed by 1 day when the daytime temperature was increased from 86°F to 95°F. However, the germination of NC 71 was delayed by 2 days (from 9 days to 11 days).

Promote Uniform Growth

Monitor and Manage Fertilizer Salts in the Growing Medium

Fertilizer salts injury is the most common nutritional problem in float systems. Fertilizers supply nutrients in the form of salts. When fertilizer is added to the waterbed, these salts dissolve in the water. Then the nutrients move into the growing medium as water is absorbed from the waterbed.

High temperatures, low humidity, and excessive air movement promote water evaporation from the surface of the growing medium, which results in the accumulation of fertilizer salts in the medium in the top of the cell. Salts can reach levels high enough to injure seedlings, even when recommended fertilization programs are followed (Figure 4-11). Fertilizer salts levels in the upper ½-inch are directly related to the total amount of fertilizer applied (in the waterbed and in the medium). Therefore, it is better to use a medium with no fertilizer (or with only a minimal amount) than to use a highly charged medium.

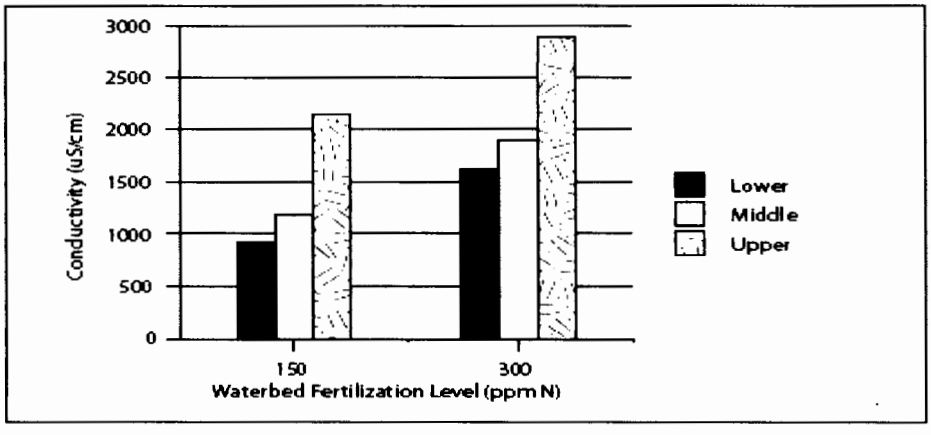


Figure 4-11. Conductivity of a soilless medium at two fertilization levels and at three depths in the cell

Electrical conductivity is a commonly used indicator of fertilizer salts levels in media and water. Pocket-sized conductivity meters are available for a reasonable price from many farm supply dealerships. When properly calibrated, these meters are very helpful in a salts-monitoring program for float water and growing media.

Salts should be monitored in the growing medium every 24 to 48 hours from seedling emergence until the plant roots grow into the waterbed. Collect a sample of the medium from the upper ½-inch of the cell from several trays, then add twice as much distilled water as growing medium on a volume basis (a 2:1 water-to-growing-medium dilution). Shake or stir the sample and wait 2 to 3 minutes before measuring the conductivity. Normal levels range from 500 to 1,000 microseimens (0.5 to 1 millimhos). Readings of 1,000 to 1,500 microseimens (1 to 1.5

millimhos) are moderately high, and readings above 1,500 microseimens are very high. Apply water from overhead to leach and dilute salts when: (1) conductivity readings are above 1,000 microseimens and plants are pale or stop growing; or (2) conductivity readings are 1,500 microseimens or above.

Fertilize Properly

Growers with fertilizer injection systems have been successful in using a constant application rate of 125 parts per million (ppm) nitrogen from 20-10-20, 16-4-16, 16-5-16, 15-5-15, or similar ratio fertilizers. For noninjected systems, fertilizer can be added to the water in two steps. Research has shown that excellent transplants can be obtained from an initial application of fertilizer to supply 100 to 150 ppm nitrogen within seven days after seeding plus a second application to supply 100 ppm nitrogen four weeks later. Use a complete fertilizer (with 2-1-2, 3-1-3, or 4-1-4 ratios) for the first application. The same fertilizer or ammonium nitrate can be used for the second application. Higher application rates cause tender, succulent seedlings that are more susceptible to diseases. Also, high application rates promote fertilizer salts injury to seedlings as noted above. If high fertilizer salts levels are detected during the first four weeks after seeding (>1,000 microseimens in the medium from the upper ½-inch of the cell), apply water uniformly from over-top to reduce fertilizer salts levels.

Monitoring waterbed fertility levels. Pocket-sized conductivity meters can be used to monitor fertility levels in waterbeds. Most fertilizer labels contain a chart that provides the expected conductivity level for the initial fertilizer concentration, usually expressed as nitrogen concentration in ppm. Conductivity is useful in measuring the accuracy of fertilizer injectors and how well the fertilizer is mixed throughout the waterbed. Conductivity measurements can also provide a rough estimate of the general fertility status in a waterbed throughout the growing season. It is important to understand that while the chart lists nitrogen concentration, the meter is measuring total conductivity from all salts (nutrients). Therefore, as the season progresses and plants adsorb nutrients from the waterbed at different rates (and water levels fluctuate), the relationship between conductivity and nitrogen concentration becomes less dependable (Figure 4-12). Therefore, collecting a water sample for analysis by the NCDA&CS (or another laboratory) is the only way to get an accurate measure of the concentrations of all nutrients in the waterbed.

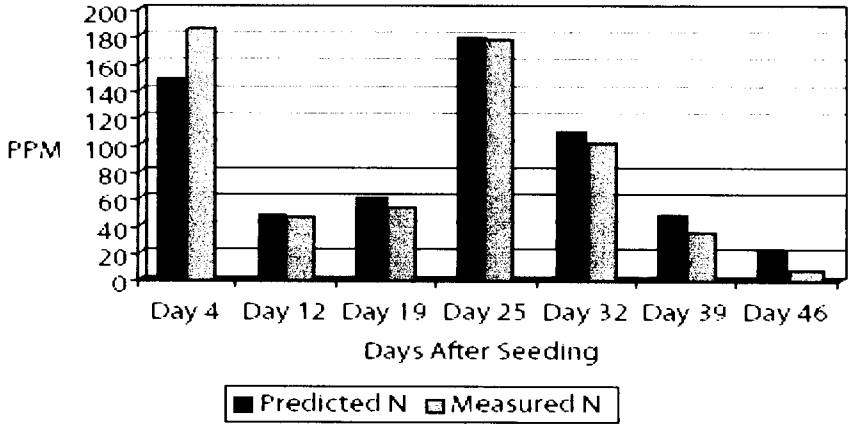


Figure 4-12. A comparison of predicted (based on conductivity) and measured nitrogen concentrations in a float bed, 2002

Nitrogen form. Fertilizers commonly provide nitrogen from various combinations of nitrate, ammonium, and urea sources. Tobacco seedlings can use nitrogen in the nitrate and ammonium forms, but urea must be converted to ammonium before the nitrogen can be used by the plant.

Exclusive use of nitrate nitrogen has been observed to raise the pH of the medium, which causes plant-growth problems similar to those caused by bicarbonates. Therefore, study the fertilizer label carefully to determine the

nitrogen form as well as the concentration of nitrogen and micronutrients. The best choice is a fertilizer that contains a balance of nitrogen in the ammonium and nitrate forms.

Effect of Urea Concentration in the Fertilizer on Seedling Stem Length, Fresh Weight, and Dry Weight, 1994

Urea Concentration	Stem Length	Fresh Weight	Dry Weight
% of total N	cm	gm/20 seedlings	
0	5.4a	77a	5.3a
52	3.8b	54b	4.0b
77	4.4b	43c	2.9c

Note: Averages followed by the same letter in a column are not statistically different and should be considered similar.

Phosphorus. Research at Clemson University has shown the need to limit phosphorus concentrations to 35 to 50 ppm in the waterbed. Applying excess phosphorus causes spindly transplants and leaves more phosphorus in the waterbed for disposal after transplant production. Therefore, 20-10-20 and 20-9-20 are better choices than 20-20-20 fertilizer. Other fertilizers, such as 15-5-15, and 16-5-16, are also good choices because very little phosphorus is left in the float water after the transplants are taken to the field. However, over-application of acidic fertilizers in low-alkalinity water can reduce the solution pH to less than 4.0, which damages roots (if plant roots grow into the waterbed).

Fertilizer effects on waterbed pH. The pH of well water in North Carolina ranges from 4.5 to 8.5. Some fertilizers, such as 15-5-15 and 21-5-20, are acidic and were designed for use in high pH (high bicarbonate) water. However, in water sources without bicarbonates or with a low pH, acidic fertilizers can reduce the pH to levels low enough to damage roots.

Studies conducted in 1997 in water with a low pH (4.8) showed that applying 15-5-15 at seeding reduced water pH. This should be expected, because this fertilizer was developed for alkaline waters. The water pH in these studies rose above 4.0 in two weeks and over 5.0 at four weeks. Root damage was not observed. The second application at four weeks again reduced the pH, but not enough to affect roots. In another study conducted in 1998, waterbed pH was reduced below 4.0 at seeding and again with the second application at four weeks. Root growth was reduced with 15-5-15 (at the high rate) compared to 20-10-20. These data indicate that the use of acidic fertilizers in low pH water can reduce the water pH below 4.0 and result in temporary root damage, particularly when applied at higher than recommended rates. The drop in water pH is temporary, and root growth recovers when the pH rises to 4.0 or higher. Effects on stem length and plant weight were not observed.

Sulfur. A sulfur deficiency is occasionally observed in float systems when the medium was not supplemented with magnesium sulfate (epsom salts) or calcium sulfate (gypsum) and sulfur was not provided by the fertilization program. The major media marketed for tobacco should contain sulfur. Also, some fertilizers such as 16-5-16 contain sulfur. If the sulfur content in a medium is questionable, the fertilizer used does not contain sulfur, or a sulfur deficiency is observed, add Epsom salts to the waterbed at a rate of 4 ounces per 100 gallons of water.

Boron. A boron deficiency causes bud distortion and death and has been observed in several float systems. In most cases, the water and the fertilizer did not contain any boron. The best solution to this situation is to choose a fertilizer such as a 20-10-20 with a guaranteed micronutrient charge if the water analysis indicates no boron. If a

fertilizer with boron is unavailable, adding no more than 0.25 ounce of Borax per 100 gallons of float water should prevent a deficiency.

Organic fertilization. In recent years, some growers have contracted to grow tobacco organically. Thus far, it has been acceptable to produce transplants with the water-soluble fertilizers typically used in float systems. However, growers may be required to use organic fertilizers during transplant production for USDA organic certification in the future. Studies were conducted in 2002 and 2003 to compare seedling production when using bat manure (8-4-1) and Peruvian seabird guano (13-8-2) to seedling production when using the standard water-soluble fertilizer 16-5-16 (Table 4-4).

Table 4-4. Effect of Fertilizer on Stem Length and Transplant Usability,2002 and 2003

	Stem Length -(cm/Plant)-		Usable Transplants -(%)-	
Fertilizer	**2002**	**2003**	**2002**	**2003**
16-5-16	8.7	5	73	88
Bat Manure (8-4-1)	2.6	1	0	0
Peruvian Seabird Guano (13-8-2)	6.8	3	77	72
Bat Manure (8-4-1) at a 3X rate	----	3	----	84

Results show that seabird guano is a better choice than bat manure when both are applied at the normal rate. Only 33 percent of the nitrogen in bat manure is in a plant-available form, which resulted in small, nitrogen-deficient seedlings when used at the normal rate in 2002 and 2003. In 2003, tripling the bat manure rate to compensate for reduced availability resulted in seedlings comparable to the seabird guano. However, a 3× rate of bat guano is very expensive.

In 2003, both organic products produced smaller seedlings and a lower percentage of usable seedlings than 16-5-16. In 2002, the seabird guano and 16-5-16 produced similar percentages of usable transplants. Based on these results, the Peruvian seabird guano seems to be a better choice than bat manure for organic seedling production. Growers using seabird guano should monitor alkalinity levels in the waterbed closely and correct when necessary.

Calculation of Water Volume

The number of gallons of water in a float bed may be calculated by:

$$\frac{\text{length (ft.) X width (ft.) x depth (in.) X 7.48 gal./cu. ft.}}{12}$$

Example: $\frac{\text{50 ft. X 16 ft. X 4 in. x 7.48}}{12} = 1994$ gal.

Calculating parts per million. Because nutrient recommendations in the float system are given on a concentration basis, growers must calculate these concentrations as parts per million (ppm). While this is very different from the traditional pounds per acre or pounds per plant bed, it really is not very difficult to calculate. The following formula is a useful way to calculate the amount of fertilizer necessary for a given concentration in the waterbed.

$$\textit{Fertilizer added per 100 gallons} = \frac{\textit{Concentration}}{\textit{\% x 0.75}}$$

Where:
Fertilizer added per 100 gallons = amount of fertilizer to add to each 100 gallons of water in the waterbed;
Concentration = desired concentration in parts per million;
% = concentration of the nutrient in the fertilizer.

Example: A grower wishes to obtain 100 parts per million nitrogen from 16-5-16. This product is 16 percent nitrogen. Therefore:

$$\frac{100}{16 \times 0.75} = 8.3 \text{ ounces of 16-5-16 per 100 gallons of water.}$$

Clip Properly

Proper clipping is an important practice that can increase the number of usable transplants and improve transplant hardiness, stem-length uniformity, and stem diameter. A properly clipped plant is essential for carousel transplanters because uniform stem lengths are needed to transplant seedlings at the proper depth, and excessive foliage disturbs the timing mechanism. Clipping can also be used to delay transplanting when field conditions are unfavorable. Research has shown that maximum usability is obtained with 3 to 5 clippings. However, many growers clip 15 to 20 times. Too many clippings indicate that the greenhouse was seeded too early. Early seeding increases heating costs as well as the potential for collar rot. Another problem is improper clipping (clipping too early and too close to the bud), which reduces stem length, increases stem rots, and slows plant growth in the field.

Research conducted by Walter Gutierrez of North Carolina State University showed that collar rot infection increased when clipping residue was left on tobacco stems and leaves. Therefore, to reduce the incidence of this disease, remove as much residue as possible. Use high-suction rotary mowers and properly collect residue with reel mowers to accomplish this.

Research conducted by David Reed at Virginia Tech showed that the severity of clipping affects stem length at the time of transplanting. For example, severe clipping (0.5 inch above the bud) decreased stem length but did not increase stem diameter as compared to normal clipping (1.5 inches above the bud). Therefore, there is no advantage

in severe clipping. Dr. Reed found that severe clipping early in the season was particularly detrimental, resulting in very short transplants that grew slowly in the field. Additional work in North Carolina indicated that severe clipping, down to the bud, immediately before transplanting reduced early-season growth and delayed flowering.

Current recommendations are to begin clipping at three- to five-day intervals when total plant height is 2 to 2.5 inches above the tray and to set the blade height at 1 to 1.5 inches above the bud. This procedure provides the best balance of uniformity, stem length, and disease management.

Figure 4-1. Effect of temperature on the germination of K 326 (2003)

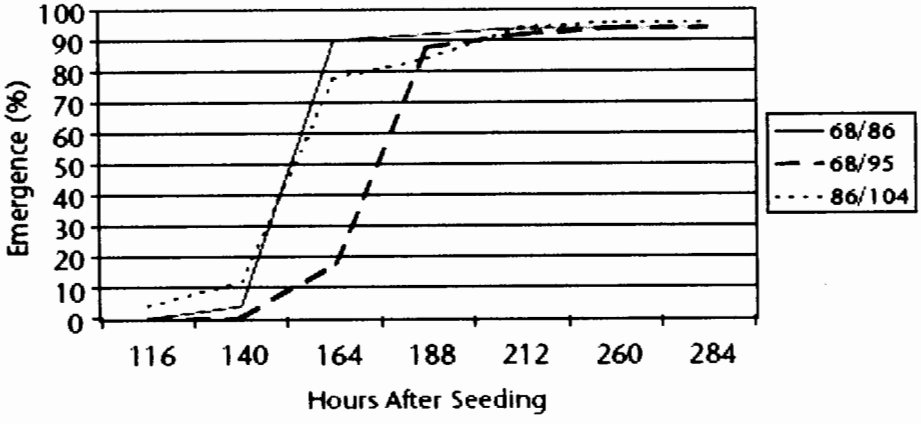


Figure 4-2. Effect of temperature on the germination of K 326 (2004)

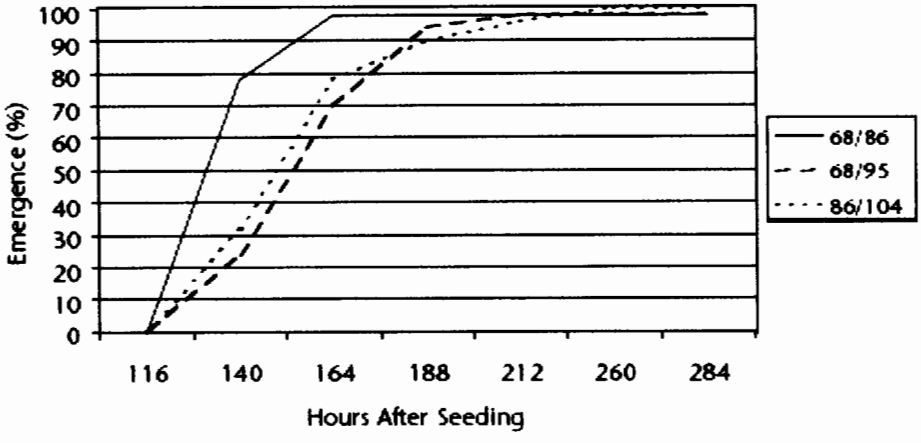


Figure 4-3. Effect of temperature on the germination of NC 71 (2003)

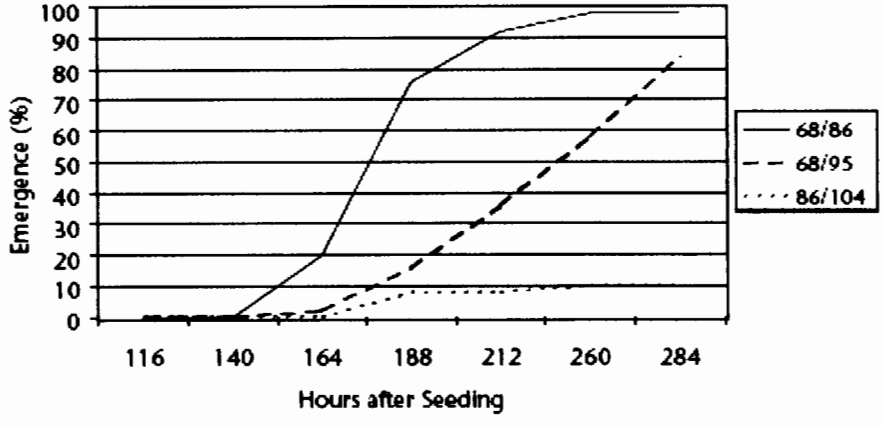


Figure 4-4. Effect of temperature on the germination of NC 71 (2004)

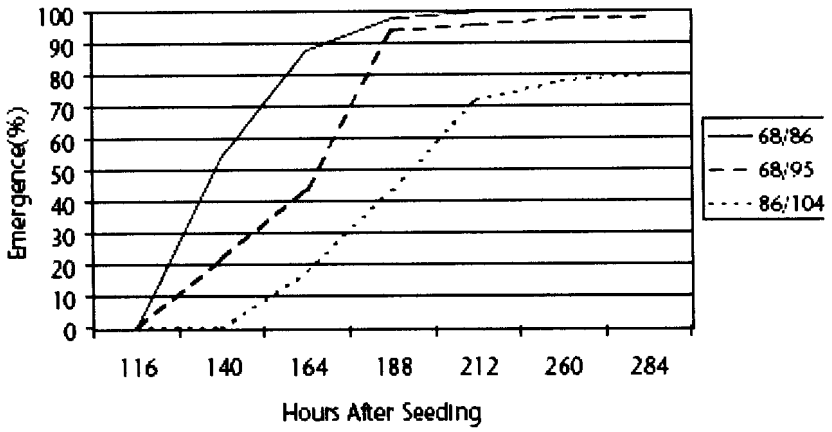


Figure 4-5. Effect of temperature on the germination of K 346 (2003)

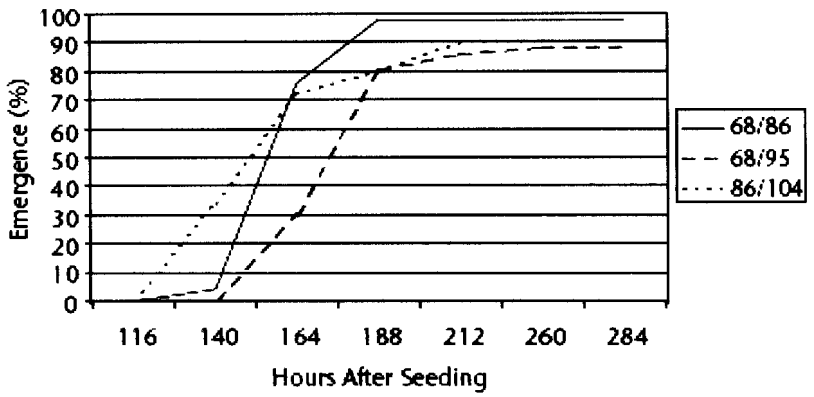


Figure 4-6. Effect of temperature on the germination of K 346 (2004)

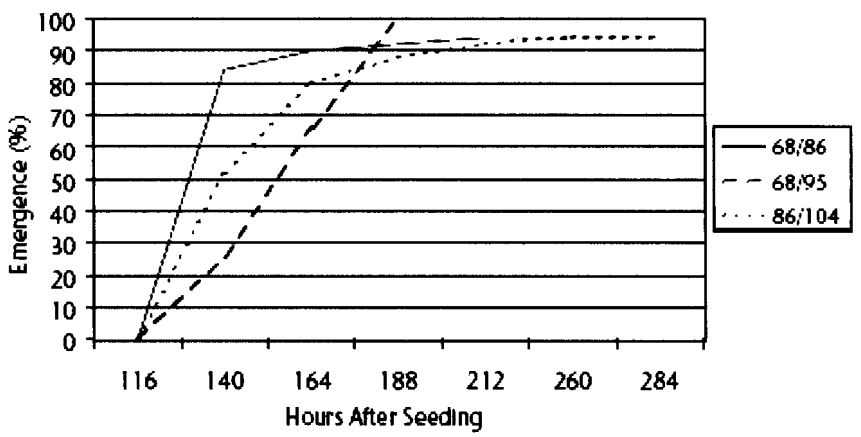


Figure 4-7. Effect of temperature on the germination of Speight 168 (2003)

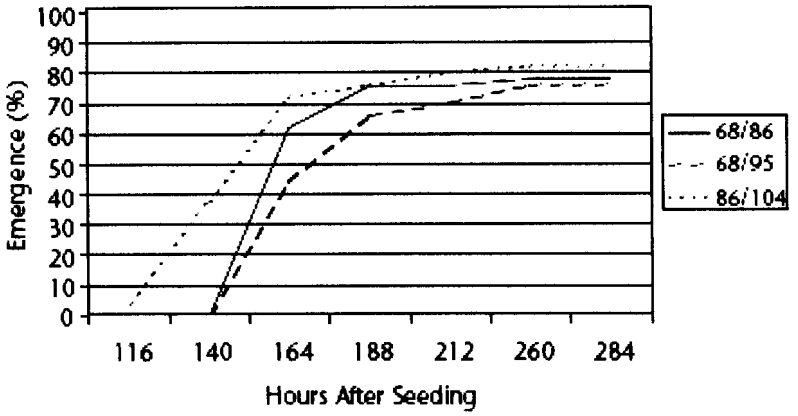


Figure 4-8. Effect of temperature on the germination of Speight 168 (2004)

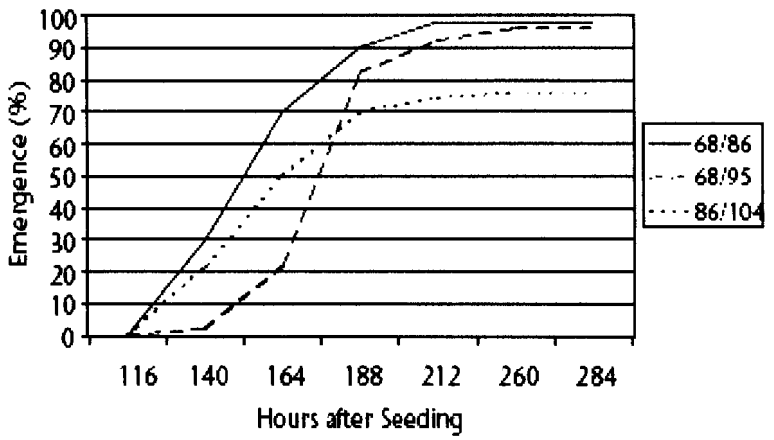


Figure 4-9. Effect of temperature on the germination of NC 297 (2003)

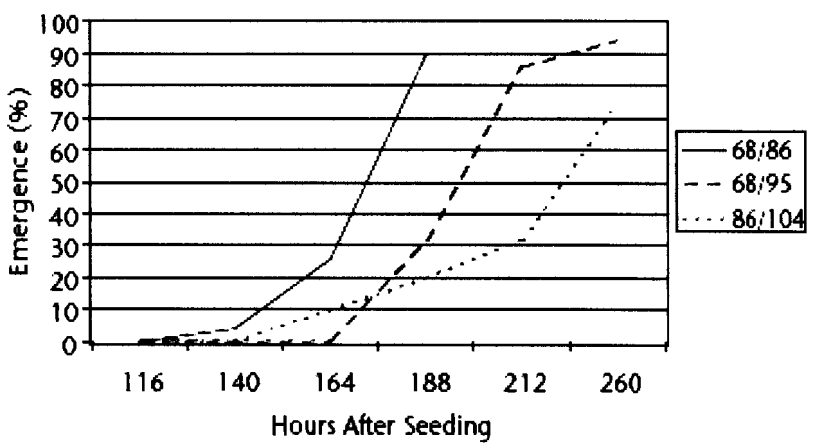
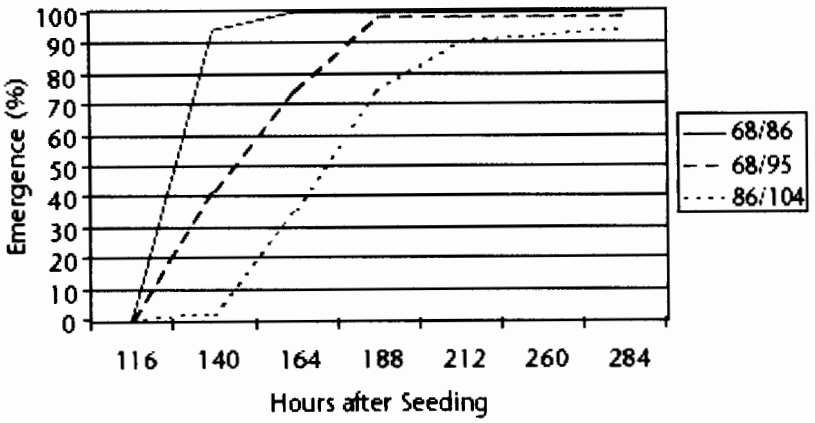


Figure 4-10. Effect of temperature on the germination of NC 297 (2004)



GREENHOUSE DISEASE CONTROL

Table 4a. Greenhouse Disease Control.

DISEASE	CHEMICAL AND FORMULATION	RATE	REMARKS AND PRECAUTIONS
Rhizoctonia, Sclerotinia and Pythium	Methyl Bromide 98%	3 lbs / 1000 cubic feet	Stack polystyrene trays loosely with sticks separating trays after each ten trays in the stack to improve movement of the gas into the trays. Release gas into and maintain a closed environment (plastic tarp or other container) for at least 72 hours when air temperature is at least 50F. Greenhouses should not be used as fumigation chambers as they cannot be properly sealed. Trays should be ventilated prior to filling with media. Proper precautions should be taken to avoid worker injury from remaining gas when the cover is opened.
Rhizoctonia, Sclerotinia and Pythium	Steam	160°F - 175°F for 30 minutes	Excessive heat for an extended period of time can cause trays to be brittle and warp resulting in problems during mechanical seeding.

Table 4b. Greenhouse Disease Control.

DISEASE	CHEMICAL AND FORMULATION	RATE PER 1000 SQ. FT.	REMARKS AND PRECAUTIONS
Blue Mold, Rhizoctonia (Damping Off & Target Spot)	mancozeb (Dithane DF, Penncozeb 75 DF)	0.5 lb (One level teaspoon per gallon)	Use 0.5 lb per 100 gallons of water. Spray to run-off (3 gallons per 1000 sq.ft.) every 5-7 days when plants reach dime size (0.5 - 1 inch tall). Gradually increase the spray volume to 6 to 12 gallons per 1000 sq.ft. as plants enlarge until transplanting to the field.
Target Spot	Azoxystrobin (Quadris F)	0.14 oz in 5 gallons of water per 1000 sq.ft.	This application allowed by GA 24c labeling. Make only one application prior to transplanting. Additional field applications may be made according to the Quadris federal label.

Table 4c. Greenhouse Disease Control.

DISEASE	CHEMICAL AND FORMULATION	RATE PER 100 GALLONS	REMARKS AND PRECAUTIONS
Pythium Root Rot	Etridiazole (Terramaster 35 WP)	2 oz.	Mix Terramaster per 100 gallons of water 2-3 weeks after seeding and again up to 8 weeks after seeding as needed. Mix Terramaster with water in a bucket and add to float water while providing thorough mixing. A sequential application may be made three weeks after the initial application as needed.
	(Terramaster 4 EC)	1 fl. oz.	

If Pythium shows up a second treatment can be made up until 8 weeks after seeding.
The plant producer assumes all responsibility for any stunting or plant injury that may occur.

TOBACCO GREENHOUSE INSECT CONTROL

Growing tobacco transplants in greenhouses has increased tremendously in Georgia over the last several years. So far insects have not caused serious problems in greenhouses, but several insects have the potential to become economic pests. Most problems have been caused by field crickets, vegetable weevils, aphids, cutworms, ants and slugs. Since a limited number of insecticides is labeled for use in greenhouses, managing insect pests requires routine inspection of greenhouses for potential problems. The following practices are recommended.

Table 3. Greenhouse Insect Control.

INSECT	CHEMICAL AND FORMULATION	RATE PER 1000 SQ. FT.	REMARKS AND PRECAUTIONS
Aphids, Cutworms or Flea Beetles	acephate (Orthene 75S) (Acephate 75SP) (Orthene 97PE)	1 tbsp in 3 gals water 1 tbsp in 3 gals water 0.75 tbsp in 3 gals water	Apply to foliage as a spray. Do not apply through an irrigation system. Over application can cause plant injury.
Aphids, Flea Beetles,	imidacloprid (Admire 2F or other generic formulations) (Admire PRO 4.6 SC) thiamethoxam (Platinum 2SC) (T-MOXX)	1.0-1.4 oz. per 1000 plants 0.5-1.2 oz. per 1000 plants 0.8-1.3 oz. per 1000 plants	Apply to foliage as a drench to trays or flats. Water in immediately, using sufficient water volume to remove any white residue from foliage.
Mole Crickets	imidacloprid (Admire 2F or other generic formulations) (Admire PRO 4.6 SC)	1.4-2.8 oz. per 1000 plants 0.6-1.2 oz. per 1000 plants	

Wirewor ms	imidacloprid (Admire 2F or other generic formulations)	1.4-2.8 oz. per 1000 plants	
	(Admire PRO 4.6 SC) thiamethoxam (Platinum 2SC) (T-MOXX)	0.5-1.2 oz. per 1000 plants 1.3 oz. per 1000 plants	
Slugs and Snails	Metaldehyde (Deadline Bullets 4% B)	0.5 - 2 lbs	Apply to margins, walkways and vacant areas at dusk. Do Not apply to float water or directly to plants.

Cultural Controls

Areas around the greenhouse should be kept free of weeds, trash, leaves, plastic, lumber and other items that offer protected sites for insects. The greenhouse should also be kept free of trash, supplies, and other unnecessary equipment that offer protected sites for insects. Vegetable weevils, slugs, crickets, grasshoppers and cutworms often move into greenhouses from sheltered areas outside the greenhouse. Aphids can migrate into greenhouses from weeds adjacent to the greenhouse and establish new colonies on tobacco seedlings. If greenhouses are used for production of ornamentals or vegetables in the off season, allow a fallow period between crops to reduce the chances of pests such as aphids or white flies being carried over to the tobacco seedlings. Keeping the greenhouse open during the winter may help reduce pests that might overwinter inside. Trays and other materials that might offer protection to pests from the cold should not be left inside the greenhouse. Closing the greenhouse during the summer and bringing the temperature up to 140°F for several days should reduce insect numbers.

Chemical Control

An insecticide must be specifically labeled for use on tobacco in a greenhouse before it can be used legally. Orthene and Admire should be applied as a spray over the top of tobacco seedlings and not in the float water (See remarks and precautions in Table 3.) Greenhouse research at North Carolina State University indicates that flat fan and solid cone nozzles give better aphid control than hollow cone nozzles. Metaldehyde (Deadline Bullets) is labeled for slugs and snails in the greenhouse. It should be applied to walkways and margins and not directly to seedlings in the float beds.

TRANSPLANT WATER FERTILIZERS

The application of fertilizers in the transplant water has been discouraged because of the lack of crop response and the potential for crop injury from fertilizer salts. However, early-season growth of greenhouse transplants is occasionally slower than that from plant-bed plants. This slower growth has resulted in renewed interest in transplant water fertilizers.

Numerous on-farm tests have been conducted with several fertilizer treatments in all the flue-cured tobacco producing states. The following summary statements can be made concerning the results of the 4-year study:

- High-phosphorus transplant water treatments often stimulated early-season growth.
- Growth differences among treatments usually disappeared by flowering and there were usually no differences observed in time of flowering.
- Yield and quality were not affected by transplant water treatments at any location.
- Float water is nutritionally acceptable for use as transplant water. However, typical nutrient levels are not sufficient to affect early-season growth.
- Similar field responses to transplant water treatments were observed for plantbed and greenhouse transplants.

Based on these studies it is likely that some fertilizers, particularly those high in phosphorus, will enhance early-season growth. However, it is doubtful that these fertilizers will promote earlier harvest. It is also unlikely that yield or quality will be enhanced.

It is important to remember that there is a level of risk associated with any product, particularly a fertilizer, added to the transplant water. These studies dealt with a relatively small number of fertilizers that were applied with high rates of transplant water (about 300 gallons per acre).

Fertilizer salt injury to tobacco roots is possible

(1) when transplant water fertilizers are not applied according to label directions;
(2) when low (less than 200 gallons per acre) rates of transplant water are used;
(3) when the soil is dry;
(4) when the regular fertilizer was applied broadcast or in the row ridge before transplanting; or
(5) with transplant water fertilizers that have not been tested on tobacco.

Also, adding field-type fertilizers such as 16-0-0 and 30% nitrogen solution to transplant water usually injures or kills transplants.

DETERMINING PLANT NUMBER PER ACRE

Each year growers have questions relating to determining plant numbers per acre. The table below may be useful in planning for planting density. In recent years growers have tended to increase the plant population per acre in an attempt to compensate for losses to tomato spotted wilt virus. While this may be helpful when losses are single plants, this approach may not be as helpful when losses are more than one plant consecutively. While yields may be increased by increasing plant populations under certain conditions the percent yield increase is not comparable to the percent increase in plant population. Overplanting results in the need for greater numbers of transplants and the handling of greater numbers of leaves. While this factor may not be as important today with mechanical harvesting as in previous years when harvest was all a result of hand labor there is a cost for handling a greater number of lighter leaves per box or barn. Previous work indicates best overall performance is a result of combinations of row width, in-row spacing and topping height which yields approximately 120,000 leaves per acre.

Number of Plants Per Acre Needed at Various Row Widths and Drill Distances

		Row Width (feet/inches)								
Drill Distance		3.00	3.17	3.33	3.50	3.67	3.83	4.00	4.17	4.33
(feet)	**(inches)**	**36**	**38**	**40**	**42**	**44**	**46**	**48**	**50**	**52**
1.33	**16**	10890	10317	9801	9334	8910	8523	8168	7841	7539
1.50	**18**	9680	9171	8712	8297	7920	7576	7260	6970	6702
1.67	**20**	8712	8253	7841	7467	7128	6818	6534	6273	6031
1.83	**22**	7920	7503	7128	6789	6480	6198	5940	5702	5483
2.00	**24**	7260	6878	6534	6223	5940	5682	5445	5227	5026
2.17	**26**	6702	6349	6031	5744	5483	5245	5026	4825	4640

FERTILIZATION

J. Michael Moore
Glendon H. Harris

NUTRIENT UPTAKE BY TOBACCO

As a guide to the fertilizer you should be using, it helps to know how much of each nutrient is taken up by the tobacco plant throughout the season (Table 1). In particular, the amount of P taken up by the plant is very small in relation to the amounts typically applied. A large part of the applied nutrients remain in the soil when the crop is removed. Soil testing is the best way to determine base fertilizer rates.

Table 1. Nutrients taken up and removed by a 3,000 pound per acre tobacco crop.

Nutrient	Uptake	Removal
	----------pounds per acre----------	
Nitrogen	126	84
Phosphorus (P_2O_5)	26	15
Potassium (K_2O)	257	156
Magnesium (Mg)	23	NA
Sulfur (S)	19	NA

SOIL TESTING

The soil test is a valuable diagnostic tool for monitoring soil nutrient status and fertilizer needs. Efficient nutrient use can help reduce fertilizer costs and help protect the farm environment without reducing yield or quality. One of the most important aspects of soil sampling is obtaining a sample that is representative of the soil conditions. Different soil types should be sampled separately. Each soil sample should represent no more than a 10-15 acre area, and should contain soil combined from 15 to 20 separate cores. This combined sample, weighing 1-2 pounds, must adequately represent the soil condition of 20-30 million pounds of soil, so careful sampling is a must. An improperly collected sample will be meaningless, and the corresponding recommendations will be poorly suited for the actual soil conditions.

INTERPRETING SOIL TEST RECOMMENDATIONS

Based on the nutrient levels found in the soil sample, recommended rates for each nutrient should supply the amount needed by the crop under average to good growing conditions. Nitrogen is <u>not</u> measured in soil samples. Soil N changes very quickly, and good measurements require special sampling and storage procedures. Recommendations for N (See Nitrogen section below) are based on numerous experiments and the measured requirements of the crop. Soil P and K index values represent the relative availability of these nutrients, not the total P and K in the soil. Recommendations are based on experiments relating response of tobacco to nutrient additions in soils at each soil test level. While a high soil test rating does not rule out a profitable response to fertilizers if all other factors are favorable, the chances of a response are quite low. On the other hand, a soil with a low rating generally will respond to inputs of that nutrient unless prevented by other factors such as adverse climate, poor management, or uncontrolled pest problems. General soil test recommendations are given in Table 2.

A soil test is helpful in determining the pH and availability of nutrients. A total fertilizer program involves more than adding the recommended lime and nutrients. You need to consider residual nitrogen, leaching, placement and timing of nutrient applications. Over-fertilization with N, Cl and certain micronutrients can decrease yield and quality of tobacco, increase production costs, and may adversely affect water quality in parts of Georgia. Excessive use of P, K, Mg and S may have little effect on yields or quality but will certainly increase costs. Society may see fit to impose limits on use of fertilizers and chemicals if farm inputs are not wisely managed. Use your soil test results, the information contained below, along with your experience to develop a fertilization program that will work for you.

Table 2. Phosphorus and Potassium Recommendations Based on Soil Test Ratings

	pounds N - P_2O_5 - K_2O to apply per acre			
P Rating	**Low K**	**Medium K**	**High K**	**Very High K**
Low	60-100-180	60-100-160	60-100-140	60-100-100
Medium	60-80-180	60-80-160	60-80-140	60-80-100
High	60-40-180	60-40-160	60-40-140	60-40-100
Very High	60-20-180	60-20-160	60-20-140	60-20-100

LIMING (pH, Calcium and Magnesium)

The optimum pH for tobacco production is 5.7 to 6.0, although good growth can be obtained at higher and lower values depending on the soil type, disease pressure, and how recently the field has been limed. Never apply lime without a soil test. When lime is applied, always use dolomitic lime which supplies both Ca and Mg. Soils with pH values in the optimum range will generally provide ample Ca and Mg to the plants. On deep sands, additional Mg may be required under conditions of heavy leaching the second or third year after liming. This should be supplied in the mixed fertilizer.

On low, wet soils of the Flatwoods, lime should be used with great caution. Heavy applications of lime on these soils can result in frenching and other problems. At optimum pH, these soils can supply adequate amounts of micronutrients. But as pH increases above 6.3, micronutrients, particularly manganese (Mn), become tightly bound to the soil and deficiencies can result.

NITROGEN (N)

More than any other nutrient, N management affects yield and quality of tobacco. When plants suffer a lack of N, yields are reduced, and the resulting cured leaf is pale and slick with poor texture. While excessive N may slightly increase yields, it also stimulates excessive suckering, delays maturity, and may result in dark colored, unripe cured leaf. Effects on quality are most pronounced in dry years. Total N requirements for tobacco should be based on plant requirements, soil texture, soil depth, residual N levels, tobacco variety characteristics, and adjustments for leaching losses.

BASE NITROGEN RATE

Your base N rate should be determined by soil texture and soil depth. Finer-textured soils will hold water and N better and tobacco grown on them will require less applied N than deep sandy soils. For soils with sandy surface horizons, depth to the finer textured horizon is the next most important factor in determining the base N rate. This depth can be measured with a shovel, a soil auger, or even estimated from a published soil survey map. Once the depth to the finer-textured subsoil is known, use Table 3 to estimate your base N rate.

Adjustments to the base rate should include allowance for residual N from the preceding crop. Following a heavily fertilized corn crop (especially if yields were lower than expected), or a legume such as peanuts or soybeans, reduce your total N rate by 10-20 lbs. If the cultivar you plant is known to mature late or cure poorly when overfertilized with N, decrease the base rate by 5-10 lbs/A. Finally, use your experience with tobacco on your particular soils to make any additional adjustments in N rate.

Table 3. Recommended Base Nitrogen Rates for Tobacco Based on Topsoil Depth

Topsoil Depth	Nitrogen Rate
inches	pounds per acre
5	50
10	60
15	70
20	80

In the past, some growers have used high initial N rates to grow a good stalk of tobacco, then used heavy irrigations to leach excess fertilizer from the soil profile. This practice can seriously affect your water quality, wastes money, depletes natural resources, and simply should not be used.

The best means of avoiding problems due to over-fertilization is to prevent excess application of N in the first place. When over-fertilization does occur, such as in replacing leached fertilizer, negative effects may be reduced by topping several leaves higher than normal, allowing plants to remain in full flower for several days, and/or delaying harvest until tobacco ripens. Leaving plants in full flower increases the risk of plants blowing over during thunderstorms and other periods of high wind. While excess nitrogen may increase yield, it complicates harvesting and curing and generally results in lower quality cured leaf. Excess nitrogen also favors development of several diseases.

LEACHING ADJUSTMENTS

Most Georgia tobacco is grown on soils that have a high rate of water infiltration, and a very low capacity to hold nutrients when large amounts of water move through the soil. Slow, lingering rains can leach N, S, K, and Mg from the root zone of deep sands. N and K losses cause the most problems for tobacco growers. These nutrients are needed in fairly large amounts to produce good quality leaf. Replace leached nutrients, especially N and K, as soon as practical. Do not delay!

Determining the correct amount of replacement fertilizer is one of the more difficult and risky tasks in tobacco production. If uncorrected, N deficiency will cause decreased yields and pale, thin-bodied tobacco. If over-corrected, the many complications of over-fertilized tobacco will be with you throughout the

remainder of the production and curing season. Replacement should be based on topsoil depth, age of the crop when leaching occurred and the estimated amount of excess water which moves through the fertilized zone. Topsoil depth determines the ease with which nutrients move from the rooting zone. Since most tobacco roots occur in the upper 12-14 inches of soil, the deeper the clay horizon below this depth, the greater the chance of nutrients moving below the root mass. Age is included because the amount of nutrients to be replaced becomes less as the plants get older. A larger portion of the required nutrients will already be in the plant, rather than in the soil. In addition, older plants will form a canopy which sheds some of the water to the row middles away from the fertilized zones beside the plant.

The most difficult factor to determine is the amount of excess water moving through the soil. Rainfall alone is an unreliable measure, since soil texture, initial soil water content, slope, crusting, and the amount and duration of the rain all influence the amount of leaching. Using past experience, growers can become reasonably good at estimating the amount of excess water and amount of replacement N required. This skill can be refined by keeping up to date records of the amount of rain, and estimates of the amount that actually soaked into the soil. Table 4 suggests the percent of the base fertilizer rate to replace under various soil and leaching conditions. NOTE: If more than the recommended base rate has been applied, the excess N applied should be subtracted from the replacement amount.

Table 4. Nitrogen Adjustments for Leaching Losses.

Topsoil Depth (Inches to Clay)	**Excess Water Soaking Into the Soil[1]**	**Weeks after Transplanting**		
		1-3	**4-5**	**6-7**
	Inches	Pounds of N per acre to replace[2]		
Less than 10	1	0	0	0
Base N = 50 lb/A	2	10	5	0
	3	15	10	0
10-15	1	18	12	0
(Base N = 60 lb/A)	2	27	18	6
	3	36	24	9
Over 15	1	35	18	11
(Base N = 70 lb/A)	2	53	25	14
	3	70	32	18

[1] Excess water is the amount of water moving through the soil after it has reached its water holding capacity (usually 0.6 to 1.0 inch in top 12 inches). Subtract the water holding capacity and the inches of water that runs off the field from total rainfall to determine excess water.

[2] Apply about 1 lb of K_2O per lb of N when adjustments are made.

PHOSPHOROUS (P_2O_5) AND POTASSIUM (K_2O)

Standard grades of complete (or mixed) tobacco fertilizers are commonly used in Georgia. The grade is the percentage of N-P_2O_5-K_2O. A 6-6-18 grade contains 6 lb N, 6 lb P_2O_5, and 18 lb K_2O per 100 lb of fertilizer. Most of the grades used in Georgia have three times more K_2O than N, but vary in the ratio of P_2O_5 to N and K_2O. The most common grades have either a 1:0:3, 1:1:3, 1:2:3 or 1:3:3 ratio. With proper selection of the fertilizer ratio, the proper phosphorus rate can be applied without altering the rates of N and potassium.

Many growers waste money and nutrients each year by using higher than required rates of complete fertilizers. Why is this? Phosphorus does not leach very much, even on deep sandy soils. According to the Potash and Phosphate Institute, a 3000 lb crop of tobacco takes up only 26 lbs P_2O_5/A, 11 lbs of which remains in the field after harvest. Many soils used for tobacco production have received several times this rate of P_2O_5 each year they were planted to tobacco. Over 70% of the soil samples submitted to the University of Georgia for tobacco recommendations were rated high and very high in P.

Seven on-farm demonstrations in Georgia during 1990 and 1991 clearly showed that soils with high P levels can produce high yields of high quality tobacco without additional P_2O_5. On-farm experiments in 18 North Carolina locations from 1985-1987 gave similar responses. Based on these results, the University of Georgia lowered P recommendations for tobacco in 1991.

To prevent excess costs, and excessive additions of P_2O_5 and K_2O, consider the primary purpose of complete fertilizers to be the supply of required P_2O_5, a portion of the K_2O, and any additional secondary and micronutrients required by the soil test. A good general rule of thumb is to use only enough complete fertilizer to supply the recommended rate of P_2O_5 and possibly K_2O, but no more than 40 lb N/A. Thus, the recommended P_2O_5 rate should determine which ratio of mixed fertilizer to use. For recommendations of 40 lb P_2O_5 or less, use a 1:1:3 ratio, for 40-80 lbs P_2O_5, use a 1:2:3 ratio, and for greater than 80 lbs P_2O_5 use a 1:3:3 ratio. Additional N (and K_2O if necessary) can be supplied much cheaper as 1:0:0 or 1:0:1 sidedress materials than as complete fertilizers.
The soil test recommendation can also be used to select the proper ratio for a sidedress material. If 120 lbs K_2O or less is recommended, all the K_2O can be supplied with mixed fertilizers. In this situation, use a 1:0:0 sidedress material such as 16-0-0 (sodium nitrate) or 15.5-0-0 (calcium nitrate) to supply the remaining N requirement. When higher rates are required, a 1:0:1 sidedress material such as 15-0-14 can be used. Requirements in excess of 160 lbs K_2O/A would justify use of a 1:0:3 grade sidedress material such as 8-0-24 or 13-0-44). If additional Mg or S is required as sidedressings on deep sands for replacing leached fertilizers, 150 lbs/A of potassium-magnesium-sulfate (Sul-Po-Mag or K-Mag) can be blended with a 1:0:0 sidedress material.

SECONDARY NUTRIENTS

The secondary nutrients (Ca, Mg, and S) are often included in complete tobacco fertilizers. They may also be added using other readily available nutrient sources such as dolomitic lime (Ca,Mg), gypsum (Ca, S), potassium-magnesium-sulfate (K,Mg,S). Soil testing is strongly recommended to determine the need for lime and supplemental Ca or Mg.

MICRONUTRIENTS

Responses to micronutrient additions on tobacco seldom occur on Georgia soils that have been in cultivation for several years. Tobacco generally is less sensitive to low levels of micronutrients than other agronomic crops. Problems generally arise on new ground, soils that have been overlimed, or on soils testing very high in soil P.

While addition of micronutrients should certainly be used when indicated by low soil test levels or tissue analysis, these materials add considerably to the cost of fertilization and should be used only when needed.

TIMING

Proper fertilization of tobacco requires a working knowledge of the soil, the amounts required by the crop, and when nutrients are in critical demand by the crop. The major goal of a tobacco fertilization program should be to avoid excessive nutrient additions while providing sufficient nutrients to maintain a vigorously growing crop. Georgia tobacco is grown predominately on soils with sandy surface textures. Such soils are subject to leaching losses, low nutrient supplying power and drought. On the other hand, N can be more easily managed to "run out" at the proper time on sandy soils than on heavier textured soils. Sands are also much easier to prepare, shape and cultivate than clays. Just as drought can be handled with a good irrigation program, the negative factors of sandy soils can best be managed using a good soil testing program and well timed, split applications of fertilizers. Using such best management practices, Georgia growers can increase fertilizer efficiency, reduce pollution potential and maximize profits.

When should fertilizers be applied? Until plants recover from the shock of transplanting, little nutrient uptake will occur. Thus, it makes little sense to fertilize the beds several days prior to planting. The first application of fertilizer (all complete fertilizer containing no more than 40 pounds N per acre) should be made at or within a few days after transplanting. This application will insure adequate levels of less leachable nutrients such as P, K, Mg, and any required micronutrients, as well as a portion of the leachable N. The remaining applications, containing only N (and K if required), should be placed no more than six inches from the row. By adding these nutrients in steps, potential for loss of nitrate-N through leaching is greatly reduced. Since most tobacco in Georgia is irrigated, there is little likelihood that late applications of fertilizers will not be moved into the root zone and available for plant uptake. Very rapid vegetative growth occurs from the fourth to the seventh week after transplanting. All fertilizer materials should be applied before rapid growth begins in the third to fourth week after transplanting. Applications after this time may be available in later stages of growth, delaying N depletion, delaying maturity, and adversely affecting quality. When managed properly, soil N levels should decline rapidly as full flowering approaches. After topping, the plants should begin to break from a dark green color to a lighter green color as the N depletion nears completion.

STARTERS

Starter fertilizers are commonly used on several agronomic crops. But many years of testing show little or no benefit from the use of starter fertilizers on tobacco. It is not uncommon to see the roots of tobacco transplants injured where starters have been used. The lack of response to starters is very likely related to the common practice of banding fertilizer close to the row. As a result of banding fertilizers, nutrient concentrations near the row are relatively high. The combination of fertilizer salts from banded fertilizers and starters can be high enough to damage tender roots.

2006 Bowen Farm Transplant Water Fertilizer / Starter Test

One test conducted on the Bowen Farm of the Coastal Plain Experiment Station in Tifton included both transplant water fertilizer materials and starter materials (Table 1.). The indicated transplant water fertilizer materials (Trts 2 - 5) were added to water prior to being added to the transplanter water barrel during the filling process. The action of the water being added was the only agitation available for these solutions during the transplanting process. Three additional treatments (trts 6, 7, 8) of starter type fertilizers were included. Treatment 6 was a commercial 10-34-0 pop-up material which is used by a number of growers in the state. Treatments 7 and 8 are common side dress materials containing only nitrate nitrogen. These were applied in the press wheel track after transplanting. Plots at the Bowen Farm consisted of 1 row of tobacco spaced 44 inches apart and 58.5 feet long to allow 35 plant plots. Treatments were replicated 4 times and were arranged in a randomized complete block design. Transplant water

fertilizer treatments were applied using a mechanical transplanter. Treatments, application rates and the resulting yield, grade index, price index, value, visual rating, total alkaloids, reducing sugars and the ratio of reducing sugars to total alkaloids of cured leaf from the transplant water fertilizer test are presented in Table 1.

Yields for all treatments did not differ significantly from the check. Transplant water fertilizer materials did not generally improve yield or quality of the cured leaf produced. However, treatments containing 9-45-15, 10-52-8 or 8-31-4 had visually more uniform and greater early growth and appearance. These findings are similar to previous work with these types of materials throughout the flue-cured production area of the United States.

Table 1. Yield, Grade Index, Price Index, Value, Visual Rating, Total Alkaloids, Reducing Sugars and the Ratio of Reducing Sugars to Total Alkaloids of Cured Leaf From the Transplant Water Fertilizer Test on the Bowen Farm of the Coastal Plain Experiment Station, Tift County, 2006.

No.	Treatments	Rate /A	Yield	Grade Index	Price Index	Value	Visual Rating	Total Alkaloids	Reducing Sugars	Ratio RS/TA
			lb/A	1-99	$/lb	$/A	(1-10)	%	%	
1	Check	----	2435 a	71.6 a	1.07 a	2637 a	2.75	2.77	17.6	1.79
2	Ultrasol (9-45-15)	6 lbs/100 gal	2823 a	71.4 a	1.07 a	2984 a	6.75	3.19	16.5	1.90
3	Ultrasol (10-52-8)	6 lbs/100 gal	2497 a	71.0 a	1.09 a	2723 a	8.25	3.30	15.1	2.03
4	Jump Start (8-31-4)	4 qts/A	2700 a	72.6 a	1.12 a	3010 a	7.5	2.89	16.7	1.92
5	Jump Start (8-31-4)	6 qts/A	2862 a	74.5 a	1.15 a	3301 a	6.5	3.12	16.5	1.94
6	Pop-Up (10-34-0)	12 gal/A	2294 a	75.6 a	1.17 a	2693 a	6.0	3.43	14.9	2.07
7	Calcium Nitrate (15.5-0-0)(soda flo)	90 lb/A	2457 a	67.8 a	0.96 a	2373 a	4.0	3.54	13.5	2.18
8	Sodium Nitrate (16-0-0)(soda flo)	90 lb/A	2640 a	73.6 a	1.07 a	2832 a	4.0	3.12	15.8	1.95
	LSD (P>0.05)		NS	NS	NS	NS				

Grade Index is a numerical value ranging from 1-99 for flue-cured tobacco based on equivalent grades - the higher the number the higher the grade.

Price Index is based on a two year floating average (2005-2006) price for U. S. government grades.

Visual Rating (1-10) 10 = best

FERTILIZER APPLICATOR CALIBRATION

Paul E. Sumner

The following procedure will give the pounds (total weight) of material applied per acre broadcast or row basis as indicated for large volumes (i.e., 10 pounds and up). This calibration procedure is based on $^{1}/_{16}$ of an acre. Which is equal to 16 ounces in a pound of material. The measured distances indicated in Table 2 corresponds to the liquid sprayer calibration but the material collected is multiplied by 8 to obtain rate per acre.

A weight scale incremented in ounces is required for this procedure. Check uniformity of outlets across the swath or rows. Collect from each for a known time period. Each outlet should be within 5 percent of the average output. Exercise extreme care and use protective equipment when an active ingredient is involved.

Step 1. Determine type of application to be made and select appropriate procedure from Table 1.
Example - Broadcast - Procedure A.

Table 1. Calibration for Application of Dry Fertilizer.

Type of Application	Procedure	Coverage Basis (Volume of Application)
Broadcast	A	Broadcast (lbs/acre)
Band	B	Broadcast (lbs/acre of band)

Note: Determine and use average row spacing for modified row patterns.
Use width of area covered per row as row spacing in skip row patterns for broadcast rates.

Step 2. Using procedure A or B below as selected in Step 1. determine appropriate calibration distance from Table 2.

A. BROADCAST APPLICATION: Outlets must be evenly spaced. Measure outlet spacing. Find this spacing in left column of Table 2. and read the corresponding calibration distance. EXAMPLE: for a 19" spacing the distance would be 214.9 feet.

B. BAND APPLICATION: Measure band width. Find this band width in the left column of Table 2.
and read the corresponding calibration distance.
EXAMPLE: for a 12" band, the distance would be 340.3.

Step 3. Measure and mark calibration distance in a typical portion of the field to be treated

Step 4. With all attachments in operation (harrows, planters, etc.) and traveling at the desired operating speed, determine the number of seconds it takes to travel calibration distance. Be sure machinery is traveling at full operating speed the full length of the calibration distance. Mark or make a note of engine rpm. Machine must be operated at same speed used for calibration.

Step 5. With applicator sitting still and operating at same speed as used in step 4, adjust gate openings to desired setting.

Step 6.** PROCEDURE A, Step 2, broadcast application collect from one outlet for the number of seconds required to travel the calibration distance.

PROCEDURE B, Step 2, band application collect from all outlets used on one band width for the number of seconds required to travel the calibration distance.

** For ground driven equipment, multiply the calibration distance by 8 and collect from each outlet while traveling the calibration distance.

Step 7. Weigh the amount of material collected in ounces. The number of ounces collected multiplied by 8 is the pounds per acre rate on the coverage basis selected in Table 1. For example, if you collect 40 ounces using procedure A or B, the applicator will apply 40 multiplied by 8 = 320 pounds per acre on a broadcast coverage basis. Adjust applicator speed, gate opening, etc. to obtain recommended rate.

Step 8. Applicators should be checked for proper calibration every 4 - 8 hours of use. Simply repeat steps 6 and 7. If there is a difference of more than 5 percent of original calibration, check the system.

BAND APPLICATION

To determine the pounds of material required to make a band application on a field, the number of acres that will be in the actually treated band must be determined. When all treated bands are the same width and all untreated bands are the same width, which is usually the case, the acres in the actually treated band can be calculated by placing the width of the treated band over the sum of the widths of the treated band and the untreated band, and multiplying this fraction times the number of acres in the field. Example - How many acres will actually be treated in a 30 acre field if a 12 inch band of material is applied over the drill of rows spaced 36 inches apart. The treated band width is 12 inches. The untreated band width is 24 inches. Acres actually treated will be

$$\frac{12"}{12" + 24"} \times 30 \text{ acres} = 10 \text{ acres.}$$

The amount of material required will be 10 times the number of pounds per acre from Step 7. Check rate recommendations carefully as to type of application, broadcast, band, and type of material specified, formulated product, active ingredient, etc.

Table 2. Calibration Distances for Various Row and Outlet Spacings or Band Widths

Row Spacing, Outlet Spacing or Band Width (whichever applies) (inches)[2]	Calibration Distance Distance[1] (feet)
48	85.8
46	88.8
44	92.8
42	97.2
40	102.1
38	107.5
36	113.4
34	120.1
32	127.6
30	136.1
24	170.2
20	204.2
19	214.9
18	226.9
12	340.3
10	408.4
8	510.5

[1] To determine distance for spacing or band width not listed, divide the spacing or band width expressed in feet into 340.3. Example: for a 13" band the calibration distance would be 340 divided by 13/12 = 314.1.

[2] To increase calibration accuracy for a wide outlet spacing, multiply calibration distance by a factor (for example, 2); then, divide Step 7 by the same factor for pounds per acre. For narrow spacings with long calibration distances, divide calibration distance by a factor (for example, 4); then, multiply Step 7 by the same factor for pounds per acre.

IRRIGATING TOBACCO

J. Michael Moore

Irrigation is an important component for the production of quality tobacco in Georgia. Rainfall is unpredictable and generally unreliable during the critical growth period. Irrigation is typically used to supplement water needs during periods of rainfall deficit. Too often, water is applied in a haphazard manner with little regard to the water needs of the crop. Research has indicated that underwatering as well as overwatering can significantly reduce both tobacco yield and quality. It is important to apply the water at the proper times and in the appropriate amounts.

Tobacco is generally considered a drought tolerant plant and is much better produced with less than desirable moisture than with excessive soil moisture. The root system is very susceptible to water saturated soil conditions and when adversely affected in this manner yield and quality can be seriously reduced. Under conditions of inadequate soil moisture, tobacco can benefit from timely application of water in amounts to bring the soil moisture level up to or close to field capacity. Over-application of irrigation should be avoided because of the wasteful nature of the use of excessive water and the possibility of negatively affecting yield and quality of the cured leaf by causing damage to the root system or leaching needed nutrients below the root zone and out of reach of the roots.

BENEFITS/RISKS OF IRRIGATION

The benefits of irrigation on tobacco, when needed, are well documented and include improvements in both the physical and chemical nature of the cured leaf. Irrigation may cause plant development to be different from plants grown under moisture stress. Physical and chemical properties of cured leaf may also be changed by irrigation resulting in leaf which is lighter in color, thinner and lower in oils and total alkaloids and total nitrogen than tobacco which has been grown with insufficient moisture. Irrigation increases the sugar content of tobacco leaf and decreases the nicotine content when applied in needed amounts.

Yields are generally expected to increase when irrigation is applied during periods of dry weather. In a series of tests in North Carolina irrigation resulted in 15 percent more yield and 10 percent higher price than for non-irrigated tobacco. Increased yield results from development of a more extensive root system which produces larger leaves, leaves spaced slightly farther apart on the stalk, stalks which grow taller and more harvestable leaves per plant.

Irrigation has also been shown to result in less sucker growth per plant and plants which flower earlier than non-irrigated tobacco. Earlier flowering shortens the period for disease and insect infestations and allows for earlier harvesting of the crop in areas where important such as in Canada where early harvesting may avoid frost injury.

Light irrigation at transplanting time will improve liveability and early growth of new transplants by enabling plants to initiate root growth earlier and by reducing the potential fertilizer injury when weather conditions are extremely dry following transplanting.

Irrigation during later stages of growth reduces the amount of scalding of upper leaves and "firing" of the lower leaves which often occur during dry, hot weather. Faster growth and earlier maturity resulting from timely irrigation may reduce the risk of hail damage and build-up of root diseases, such as black shank, nematodes and insects. Yield and quality losses due to tobacco mosaic virus may be reduced by timely irrigations.

Curability of the tobacco leaf may be improved by increasing the moisture content of the green leaves when harvesting takes place during extremely hot, dry weather.

A number of risks are also associated with irrigation. The possibility of getting an extended rainy period immediately after irrigation is always a risk. Excessive irrigation or rainfall can cause tobacco to ripen faster as a result of nutrient leaching and/or root injury. Contamination of fields with disease organisms in irrigation water which may have received runoff from an infested field should be considered a risk of some impounded water sources. Extensive irrigation late in the harvest stage may mobilize remaining soil nitrogen, allowing it to be taken up by the plant, causing regreening of leaves, and resulting in a lowering of leaf quality.

TOBACCO GROWTH STAGES AND WATER NEEDS

The growth of the tobacco plant, as produced for flue-cured tobacco, may be divided into several stages or phases including; transplant production, transplanting until knee-high, rapid growth, and harvest. Tobacco may benefit from irrigation at all stages of growth if soil conditions are dry and rainfall is inadequate to support the growth of the plant. Leaf quality of tobacco can be significantly affected by irrigation at two stages of growth and development; (i) the rapid growth phase and (ii) harvest. Tobacco may be irrigated any time during the day or night. However, more efficient use of the water may be made by application at night rather than during the hot part of the day. Irrigation in the early morning when possible may help prevent the spread of diseases such as rhizoctonia, blue mold and brown spot.

Plant beds require a uniform supply of soil moisture. Germination of tobacco seed is dependent on temperature, light and soil moisture. Although a minimum of moisture is required for germination, adequate soil moisture is required. When plant beds are covered with porous covers, the soil moisture evaporates rapidly and plant beds require multiple light irrigations to insure germination and establishment. When nonporous covers are used at the time of seeding, a single irrigation of 0.25 inch to 0.35 inch after seeding is usually sufficient to meet the needs of the seedlings until temperatures increase to the point that the covers are removed. In moderate climates irrigation with 0.5 inch of water will normally meet the needs of plant beds which have become dry. Withholding irrigation just prior to pulling transplants is used in droughty production areas to harden plants before going to the field and promote root regeneration.

At transplanting a small amount of water (approximately 100 to 200 gal/A) is applied as each plant as it is placed in the soil. This water creates a hospitable environment for new root development and provides good soil contact with existing plant roots.

After transplanting and before severe wilting occurs an application of approximately 0.5 inch of irrigation is recommended to wet the soil slightly deeper than the roots. Irrigation after transplanting is better than before transplanting. Drier soils compact less with the movement of tractors and equipment across the field. Irrigation after transplanting may be the most beneficial water applied during the season. Application of additional water helps settle the soil around the roots of the plants and provides adequate moisture to encourage faster root development. Uniform wetting of the soil following transplanting helps to minimize fertilizer salts injury which is usually worse in soils which start with adequate moisture, but dry after transplanting.

During the early growth stage, from the time of transplant establishment up to the time the tobacco plants are knee-high, approximately four to six weeks after transplanting, water is withheld to create a moderate moisture stress. This moderate stress is considered beneficial to the tobacco plants as deeper root development is encouraged in preparation for the rapid growth phase. Many suggest that this additional root development results in increases in yield and quality of the cured leaf. During the early growth phase irrigation is recommended only during extended drought.

The rapid growth stage occurs from the time the tobacco plants are knee-high to early bloom, approximately from weeks four to six after transplanting. During this time moisture extremely important to the tobacco plant as it is needed to insure good leaf spread and improve yield and quality. Although an

adequate supply of soil moisture is required during the rapid growth phase, water use curves indicate that tobacco should only be irrigated often enough to keep the moisture level sufficiently high to insure rapid growth, not to exceed two inches per week. Excessive irrigation during this critical period may cause damage to the root system. A low tech approach to determine the need for irrigation is to look at the plants for signs of wilting before eleven o'clock a.m. or if the soil appears ashy in color and void of all moisture.

During harvest, irrigation is not generally required. Water loss from the plant is reduced as it approaches maturity compared to the rapid growth phase. The need for water for cell expansion decreases as leaves reach their full size and as the ripening process changes the color from green to yellow in flue-cured tobacco. Leaf cuticle and waxes increase with maturity further reducing the rate of transpiration. The transpiring surface of flue-cured tobacco is continually being reduced by individual harvests. Slight moisture stress may be beneficial by helping to reduce the severity of brown spot and slow down the harvest rate.

In extreme drought conditions irrigation during the harvest stage will increase the maturity rate of tobacco, improve curability of the leaf by allowing better yellowing, and reduce burning of leaf margins which lowers leaf quality and indicates an imbalance of chemical components.

Tobacco may ripen faster after heavy rains or heavy irrigation because (i.) part of the nitrogen is leached from the root zone, (ii) water damage occurs to the root system, or (iii.) because of physiological reactions within the leaf made favorable by higher moisture content.

Drowning is perhaps more likely to damage tobacco than most other crops. Drowning results from damage to roots by water saturation of soils in the root zone. The potential for drowning can be reduced by planting flue-cured tobacco on well-drained soils and on high, wide, row ridges to enhance drainage and raise the root system up above the saturated soils. Younger tobacco (12th leaf stage) is more susceptible to drowning than tobacco at a later growth stage (17th leaf stage). Wilting after conditions of excess soil moisture is a direct result of lack of water being transported to the shoot. Under anaerobic conditions roots are injured primarily by lack of oxygen. Water uptake by dead roots is only 40 percent of healthy roots.

DETERMINING WHEN TO IRRIGATE

Immediately after transplanting tobacco should be irrigated with about one half inch of water. This helps to settle the soil around the roots and provides moisture to stimulate fast root development. After the stand is established and until tobacco is two feet high, irrigate only after an extended dry period. It is generally accepted that slightly dry soil during this period helps to stimulate deeper root development, which benefits the plant during the later rapid growth stage. Moisture levels should be maintained near field capacity during the rapid growth stage (two feet high to early bloom). Leaf expansion and internode elongation are often severely restricted if adequate water is not available during this period. During the harvest period, irrigate tobacco only during extreme drought. The plant requires less water as it approaches maturity; however, adequate water is required for proper maturing and curability.

The need for irrigation can often be determined by simply observing the appearance of the crop and soil. If tobacco shows signs of wilting before eleven o'clock or if the soil appears ashy in color and void of all moisture, irrigation may be beneficial to the crop. Tobacco produced in areas typically dry during the production season can be irrigated based on a balance sheet approach which tracks plant water use and moisture application.

Water-Holding Capacity

The water-holding capacity of soil is extremely important to determining the need for irrigation. Pore spaces between soil particles are either large or small. The free moisture in the small pore spaces is held by capillary forces. Water is removed from large pore spaces by gravity. Coarse textured soils (sand) have larger pores. Fine textured soils (clay or silt) have smaller pores. Soils are saturated when the pores are completely filled. Soils are at field capacity when water ceases to drain from them by gravity. Drainage from saturation to field capacity for most soils used for tobacco usually requires two to three days. Sandy soils require less time for drainage than clay soils.

Tobacco plants can utilize both the water which drains from the soil by gravity and that which is held against gravity by the soil particles. Some moisture is held so tightly by the soil particles that it is unavailable to plants. Wilting point is reached when soil moisture is depleted to only that which is unavailable to the plants. Tobacco utilizes the moisture which is held against the forces of gravity, but is available to the plants.

Tobacco roots pull moisture mainly from the top 8 to 12 inches of soil. A majority of the flue-cured tobacco is grown on loamy sand or sandy loam soils with an available water-holding capacity between 0.7 to 1.5 inches of water in the root zone.

Water Loss and Use.

Water loss occurs from the soil through the process of evaporation. Water loss from the plant results from transpiration, moisture loss as vapor through plant leaves. The combined effect of these two processes is termed evapotranspiration. In Georgia evapotranspiration varies from 0.1 to 0.25 inches per day. Tobacco usually requires an average of one inch per week of water for good growth.

DETERMINING HOW MUCH WATER TO APPLY

For maximum yields, adequate soil moisture should be maintained in the top two feet of soil. Most tobacco producing soils hold about one inch of available water per foot of depth (specific information on soil water holding capacity can be obtained from SCS Soil Surveys.) In a two foot root zone this soil would hold about two inches of available water at field capacity. Highest yields are maintained when available moisture remains above 50 percent of field capacity. Therefore, the allowable depletion before irrigation would be only one inch. The required irrigation amount to replenish the field would be one inch plus losses due to evaporation and non-uniform distribution. The standard practice is to add 25% for losses, therefore the required irrigation amount is 1.25 inches. This amount will be less for sandier soils, more for loamier soils. The peak water use for tobacco is about 0.25 inch per day and occurs at about 8 weeks after transplanting (see Figure 1). During this period the soil in the previous example would require irrigation every four days. Water consumption earlier and later in the season will be considerably less and therefore irrigation will be less frequent.

Often soil moisture sensing devices are used to schedule irrigations. Examples of such devices are tensiometers and resistance blocks. Generally, two of these are installed at different depths, one near the middle of the root zone and one near the bottom. Typically, one will be installed 8 to 10 inches deep and the other 16 to 20 inches deep. The shallow devices are used to determine when to irrigate and the deeper ones are used to insure that adequate water is maintained near the bottom of the root zone (see Figure 2). A minimum of two to three sensing locations should be maintained in each field. When using tensiometers, readings should be maintained between 5 and 30 centibars during the rapid growth stage. Readings below 5 indicate that the soil is too wet and above 30 too dry. During earlier and later growth stages higher readings are acceptable. Tensiometers are an accurate means of measuring soil moisture, but they do have one drawback. If the soil is allowed to dry out to the point where the tensiometer readings go

Some farmers prefer using electric resistance blocks such as gypsum blocks or Watermark[T.M.] sensors. These are generally not quite as accurate as tensiometers but they do not require regular servicing. As a general rule you should read and record soil moisture readings at least three times per week and irrigate accordingly.

Excessive water will leach some fertilizer nutrients below the root zone and may result in lower yield and quality of the crop. Repeated light irrigation of dry soils will encourage growth of roots near the soil surface. A shallow root system makes the crop more susceptible to injury from dry and hot weather than expected with a normal root system. During the rapid growth stage it is recommended to withhold irrigation until about 40 percent of the available soil water is left and then irrigate to field capacity. More sandy soils need more frequent and lighter of irrigation and heavier soils need less frequent and heavier irrigation.

Infiltration Rate of Soils

The infiltration rate of most soils used for the production of tobacco in the southeastern United States varies from 3 inches per hour for coarse textured soils to as little as 0.5 inch or less per hour for the sandy clay loams. Infiltration rate is influenced by; compactness of soil, soil structure, organic content, presence of plant material on the surface and quantity of water already in the soil.

When water is applied faster than it can soak into the soil, it runs out the end of the row. This is wasteful of water and energy and reduces the accuracy of the estimate of water entering the soil. Infiltration is reduced as tobacco becomes larger, causing water to be shed toward the middle of the rows. The danger of runoff is greater as the tobacco plant grows.

Irrigation Scheduling

Appearance of the crop and soil can be a good indication of the need for irrigation. Look at the plants for signs of wilting before eleven o' clock or if the soil appears ashy in color.

A water balance sheet may be used to track plant water use and account for added water. Tensiometers will not accurately read low moisture levels in sandy loam soils at which tobacco can survive very well. Moisture blocks which measure electrical resistance appear much more useful for measuring soil moisture in these coarse soils. For best results scheduling should be based on the combined use of production experience, crop observation, a water balance sheet and moisture blocks.

WATER QUALITY

Various water sources may be used to irrigate tobacco. Among these water sources are; surface water supplies such as impounded ponds and streams, ground water supplies such as wells, wells plus holding ponds and municipal water systems.

Disease

In most cases the water available for irrigation would be completely suitable for use on tobacco. However, there are a number of instances when the available water are not suitable for irrigation. A number of diseases may be spread by contaminated irrigation water. Disease organisms such as black shank and Granville wilt may be spread to uninfested fields by contaminated water, especially from streams and ponds receiving drainage from infested fields. Additionally, diseases such as black shank which normally infect plants through plant roots, where resistance resides, may directly infect plants through the leaves and stems following irrigation. Additionally, brown spot sometimes appears worse following irrigation.

However, simply the application of irrigation could provide a suitable environment for infection by brown spot.

Salts in Irrigation Water

Chlorine is the element of primary concern when irrigating tobacco. Particular attention should be given to the Cl content of irrigation water if the water source at any stage of growth should happen to be a municipal water source which has been treated with Cl. No more than 30 kg Cl ha^{-1} should be applied to tobacco from all sources. Most surface water sources in Georgia contain 4-10 mg Cl L^{-1}. Thus 2.5 cm of irrigation water would deliver 126 grams of Cl for each mg L^{-1} determined to be in the irrigation water.

Manure lagoon liquid is not considered suitable for irrigation of tobacco due to both the excessive chlorine content, as well as the excessive nitrogen content of the liquid. Nitrogen content of liquid lagoon waste varies widely.

OTHER PRODUCTION PRACTICES IN RELATION TO IRRIGATION

Choose practices which will give the best results under good growing conditions. Variety selection, plant population and topping height should be selected to produce high quality leaf which is desirable to the buyers. Manage irrigation properly and do not irrigate excessively. There is no justification for changing production practices just because irrigation is to be used if only enough water is used to keep the crop in good condition.

Additional N and K may be needed with excessive irrigation or precipitation following irrigation. In studies in Virginia, irrigation depressed yields at lower and higher rates of N. Medium rates of irrigation and N interacted to increase yields. Excessive irrigation or rainfall may cause leaching of soil N below the root zone. Ripening may begin before maturation has been completed.

Some growers apply extra N at the last cultivation as insurance against leaching in wet weather which may occur during the rapid growth phase. When expected precipitation does not occur, more irrigation is required to leach extra N and maintain leaf quality. This is not an environmentally or economically sound practice.

IRRIGATION EQUIPMENT

A variety of irrigation systems are available and are used for overhead irrigation of tobacco and other crops. Gun sprinkler systems may be solid set, portable pipe sections or self propelled traveling systems. Center pivot systems can cover large primarily circular areas with a minimum of physical requirements by the operator. Complete coverage of irregular shaped fields by center pivot systems presents some problems. Self-propelled lateral move sprinkler systems have some distinct advantages in that they are able to cover rectangular shaped fields. Lateral systems require multiple risers along the lateral move path.

A variety of pumps are available which may be run by LP gas, diesel fuel or electric. Pumps may be installed permanently or they may remain portable.

DRIP IRRIGATION

Drip irrigation is another system for delivering irrigation water to tobacco. Drip irrigation is termed so because of the slow application of water delivered to plants under low pressure through emitters spaced uniformly along the length of plastic tubing. Drip irrigation can be an efficient use of water as this system has been reported to reduce water use by 30 to 50 percent.

Components of a drip irrigation system include; a water source, pump, filters, main line, water meter, check valve, low pressure drain, vacuum breaker, pressure reducer, manifold, injection pump for adding fertilizer, sub mains and drip tube with emitters.

Drip irrigation may be used with or without plastic mulch to cover the row bed into which the tobacco is planted. With plastic mulch, no cultivation is necessary and no application of chemicals or fertilizer is possible except through the irrigation water and the drip system. Without plastic mulch, conventional cultivation and fertilization is still possible. The minimal pump operating pressure for the system is a distinct advantage. Water is delivered through the drip tubing at 10 to 15 psi. A water supply which is clean with regard to micro flora growth and chemical contaminants is required. Contaminated water sources can clog filters and emitters.

Benefits of utilizing the drip system for irrigating tobacco include; efficient use of water, the possibility of injecting fertilizer through the system either to supplement or replace the normal dry fertilizer program, possible increases in the quality of the lowest plant leaves without splashing sand on these leaves, and a reduced potential for soil erosion from surface water runoff on rolling terrain.

Problems presented by drip irrigation include; expense of installing the needed wells and system components, a tendency to over irrigate causing leaching of fertilizer nutrients, a requirement for increased management ability and an understanding of the pumping and delivery system, and disposal of plastic mulch and drip tubing.

In the U.S. application of soil fumigant and plastic mulch with drip tube increases the cost of production by as much as $600.00 per acre. Permanent installation of needed wells, pumps, filters and supply lines can add as much as $1500.00 per acre to the expense of installing a drip system.

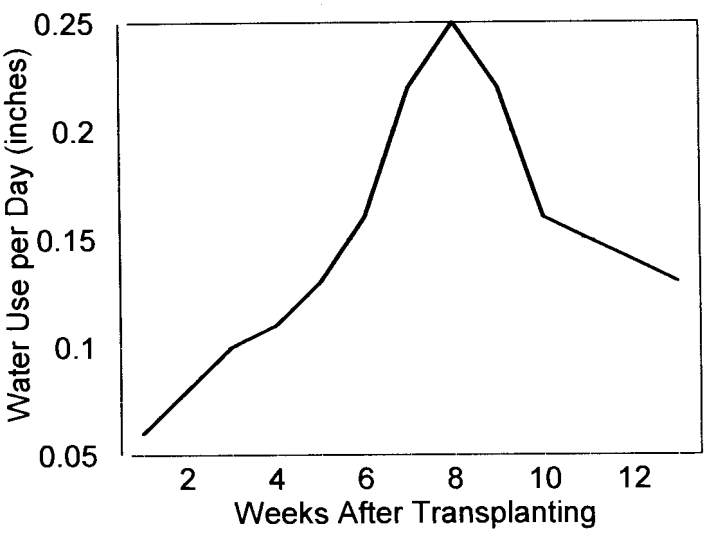


Fig. 1 Moisture Use by Tobacco (Harrison and Whitty, 1971)

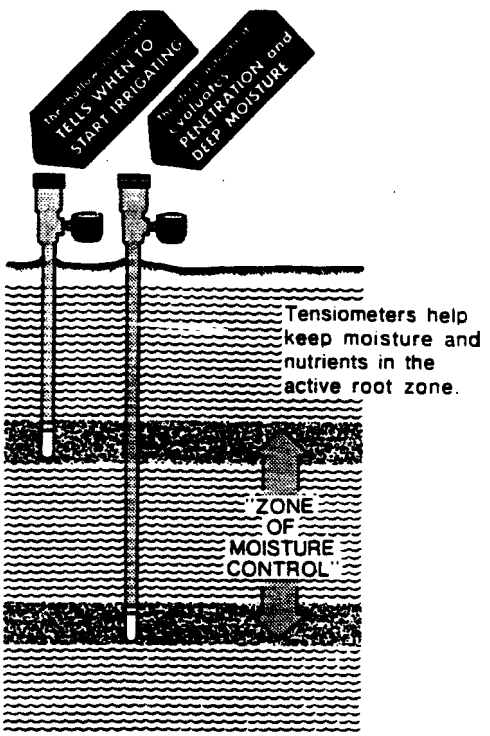


Fig. 2. Proper Use of Tensiometers

WEED MANAGEMENT

J. Michael Moore

Weeds reduce tobacco plant growth by competing with the crop for light, nutrients and water. Weeds also serve as a host for diseases and insects that attack tobacco. Since the climate in Georgia is ideal for weed growth, tobacco producers must use many tools to control and/or suppress weed infestations. Weed management includes knowledge of the pest, crop rotation and other control methods.

KNOWLEDGE OF THE PEST: Before a control measure is implemented in a tobacco field, knowledge of the pest is required. Producers must be aware of the weed species that infest an area in order to decide upon the proper control measures. Correct identification of a weed species can be obtained through the county agent. Weed maps and other documentation that are gathered over several years will help in avoiding weeds that are impossible to control in tobacco.

CROP ROTATION PRACTICES: Crop rotation practices will directly influence the weed species and pressure to expect. Rotations that include corn, cotton, sorghum or soybeans will help reduce the weed pressure in tobacco fields. IMPORTANT: Herbicides that are used in row-crop production can sometimes persist and injure tobacco planted the next season. Growers should be aware of the crop rotational restrictions BEFORE using any herbicide in a crop preceding tobacco.

CONTROL METHODS: The most effective weed control is obtained through the use of several methods:

TILLAGE AND CULTIVATION: Tillage should be used prior to transplanting tobacco to remove existing weed growth. There are no herbicides available that will kill emerged weeds without severely injuring tobacco. After transplanting, cultivation can be used to remove small weeds as they emerge. Cultivation should be shallow and should not disturb the established plants.

CHEMICAL: Herbicides are an effective tool for controlling weeds in tobacco. However, there are no herbicides labeled for use in tobacco that will control all weeds encountered in Georgia. Herbicide(s) applied before transplanting should be incorporated to control weeds before they emerge. Other herbicides are available that can be applied after transplanting. Recommendations for controlling weeds in tobacco can be found in the most current "Georgia Pest Control Handbook". The following "rules of thumb" should be used when applying herbicides: a) always calibrate the sprayer and recheck every few hours; b) check the effectiveness of the incorporation equipment; c) be familiar with the rotational restrictions and other instructions on the manufacturer's label; d) follow the safety guidelines listed by the manufacturer; e) never use a herbicide that is not specifically labeled for use on tobacco.

Table 1. Tobacco Weed Control Alternatives (multiple pages)

	BROADCAST RATE/ACRE			
TIMING	HERBICIDE FORMULATION	AMOUNT OF FORMULATION	POUNDS ACTIVE INGREDIENT/A	REMARKS AND PRECAUTIONS
PLANT BED (for control of soil fungi, bacteria, nematodes, insects and weeds)	Methyl Bromide 98%	9 lb/100 sq yd	8.82/sq yd	Apply methyl bromide when soil temperature is above 50°F.
	Methyl Bromide 68.6%	10-12 lb/100 sq yd	6.8 - 8.2/sq yd	Cans: Release gas under plastic covering. Plastic should be sealed around the edges with soil. Leave covered for 24 hours. Seed bed after 72 hours of aeration. Cylinders: Inject into well prepared soil with chisel applicators. Cover immediately with plastic and seal all edges. Leave covered for 48 hours. Remove cover to provide sufficient aeration 72 hours prior to seeding.
	metham-sodium (Vapam)	1 - 1.5 gal/100 sq yd		Spray onto moist soil in a minimum of 40 gal of water/A. Incorporate thoroughly three to four inches deep. Cover with plastic for 1 to 2 days when soil temperatures are at least 50°F. Aerate soil prior to seeding.
	Vapam + Telone C-17	37.5 gal + 10 gal		A. Spray Vapam on soil surface, chisel in Telone C-17, incorporate/seal by tiller (6" deep) behind chisels, and cover with plastic all in a single operation as with Methyl Bromide. B. After Treatment wait 7 days before punching plastic. C. After punching wait 14-21 days before seeding
(for post emergence control of grasses)	sethoxydim (Poast) 1.5 lb/gal	1.0 pt (0.33 fl oz per 100 sq yd)	0.19	For use in tobacco seedbeds only. Do not use in the field. Addition of a non-phytotoxic oil concentrate at 1 qt/A (0.67 floz per 100 sq yd) is required. Allow plants to completely dry before covering, especially with plastic.

Table 1. Tobacco Weed Control Alternatives (multiple pages)

		BROADCAST RATE/ACRE		
TIMING	HERBICIDE FORMULATION	AMOUNT OF FORMULATION	POUNDS ACTIVE INGREDIENT/A	REMARKS AND PRECAUTIONS
PREPLANT	clomazone (Command) 3ME 3 lb/gal	2.0 to 2.66 pt/A	0.75-1.0	Apply Command as a broadcast spray at low pressure and large droplet size. Incorporate to a depth not to exceed one inch prior to transplanting. Transplant roots should be placed below the treated area. Off-site movement of spray drift or vapors of Command can cause foliar whitening or yellowing of some plants (fruit and nut trees, berries, roses, other landscape plants and greenhouse plants). Temporary whitening and/or yellowing of the treated crop and rotational crops may occur. The crop should grow through this with no adverse impact. The introduction of the 3ME formulation should reduce the potential for off-site movement and injury to sensitive plants. Do not plant small grain for grain less than 12 months after application of Command. Do not graze treated areas for 9 months.
	pendimethalin (Prowl) 3.3E (Pendimax) 3.3 lb/gal (Prowl H20) 3.8 lb/gal	2.4 - 3.0 pt 2.4 - 3.0 pt 2.0 - 2.5 pt	1.0 - 1.2	Apply and soil incorporate within 14 days prior to transplanting. Prior to bedding, apply and soil incorporate either Paarlan, Prowl or Devrinol with a power-driven rotary tiller set to cut 4 inches deep or incorporate by disking and cross disking with a disk harrow set to cut 4 to 6 inches deep. If applied to preformed beds, "board off" to planting level and incorporate with a power-driven rotary tiller set to cut 4 inches deep. Devrinol is for field use only. Not labeled for tobacco seedbeds due to plant injury.
	napropamide (Devrinol) 50W (Devrinol) 2E	2 - 4 lb 2 - 4 qt	1.0 - 2.0	
PREPLANT (continued)	pebulate (Tillam) 6E 6 lb/gal	5 pt 5 fl oz	4	Tillam should be used if nutsedge is a problem in the field. Apply and incorporate immediately either before or after bedding as discussed above. If possible, apply Tillam at least 2 days before transplanting.

Table 1. Tobacco Weed Control Alternatives (multiple pages)

TIMING	HERBICIDE FORMULATION	BROADCAST RATE/ACRE AMOUNT OF FORMULATION	POUNDS ACTIVE INGREDIENT/A	REMARKS AND PRECAUTIONS
	pebulate (Tillam) 6E 6 lb/gal	5 pt 5 fl oz	4.0	Tillam and Devrinol may be tank-mixed to provide control of nut-sedge and many annual grasses and some broadleaf weeds. Apply and incorporate immediately either before or after bedding as discussed above. If possible, apply this combination at least 2 days before transplanting.
	+	+	+	
	napropamide (Devrinol) 50W	2 lb	1.0	
	(Devrinol) 2E	2 qt		
PRETRANS-PLANT (surface application only)	sulfentrazone (Spartan DF) 0.75 lb ai/lb	5.3 oz	0.25	DO NOT INCORPORATE !! CALIBRATION IS IMPORTANT !! Application rate for sulfentrazone should be limited to 0.25 lb ai per acre (5.3 oz Spartan DF or 8.0 oz Spartan 4F or 10.2 oz Spartan Charge). Excessive application rates or poor calibration may result in injury to the tobacco.
	(Spartan 4F) 4 lb ai/gal	8.0 oz		
	carfentrazone-ethyl		0.016 - 0.028	
	+	+	+	
	sulfentrazone (Spartan Charge) 0.35 + 3.15 lb ai/gal	5.7 - 10.2 oz	0.157 - 0.25	
	sulfentrazone (Spartan DF) 0.75 lb ai/lb	5.3 oz	0.25	Sulfentrazone should not to be applied to soils classified as Sand with less than 1% Organic Matter and shallow groundwater. Most Georgia tobacco soils would make the loamy sand or sandy loam categories of coarse textured soils.
	+	+		
	clomazone (Command)3ME 3 lb/gal	2.0 to 2.66 pt/A	0.75-1.0	
PRETRANS-PLANT (surface application only)	carfentrazone-ethyl		0.016 - 0.028	Application methods should be directed toward applying and maintaining Spartan/Spartan Charge at the soil surface. Spartan may be surface applied up to 14 days prior to transplanting after all other soil incorporation practices have been performed where transplanting occurs without bedding. If beds are formed prior to transplanting, the top of the beds should be dragged or knocked off prior to application of Spartan. Transplant into the treated bed without pushing additional soil from the bed. Spartan should not be incorporated into the bed greater than 2 inches.
	+		+	
	sulfentrazone (Spartan Charge) 0.35 + 3.15 lb ai/gal	5.7 - 10.2 oz	0.157 - 0.25	
	+			
	clomazone (Command)3ME 3 lb/gal	2.0 to 2.66 pt/A	0.75-1.0	

Table 1. Tobacco Weed Control Alternatives (multiple pages)

TIMING	HERBICIDE FORMULATION	BROADCAST RATE/ACRE AMOUNT OF FORMULATION	POUNDS ACTIVE INGREDIENT/A	REMARKS AND PRECAUTIONS
	sulfentrazone (Spartan DF) 0.75 lb ai/lb	5.3 oz	0.25	DO NOT APPLY SPARTAN POST-TRANSPLANT OVER THE TOP OF TOBACCO AS CROP INJURY MAY OCCUR.
	(Spartan 4F) 4 lb ai/gal	8.0 oz		
	carfentrazone-ethyl + sulfentrazone (Spartan Charge) 0.35 + 3.15 lb ai/gal	5.7 - 10.2 oz	0.016 - 0.028 + 0.157 - 0.25	Rotational Guidelines limit recropping treated soil to: wheat - 4 months, field corn - 10 months, cotton - 18 months, canola - 24 months. Although recropping to vegetables is not mentioned on the label, the limited information available would discourage recropping treated soil to most vegetables in less than 12 months after treatment.
POST TRANS-PLANTING	napropamide (Devrinol) 50W	2 - 4 lb	1.0 - 2.0	Apply directly over the top of tobacco immediately after trans-planting to control weeds before they emerge. Irrigate with 1/2 inch of water if no rainfall occurs within 3 to 4 days.
	clomazone (Command)3ME 3 lb/gal	2.0 to 2.66 pt/A	0.75-1.0	Refer to Remarks for Command under the Preplant section for comments on application, off-site movement and rotation. Tender plant bed plants and particularly greenhouse plants have been shown to be very sensitive to Command and some leaves may turn white for a short period of time. This does not usually cause a reduction in yield and has not been widely observed in Georgia.

Table 1. Tobacco Weed Control Alternatives (multiple pages)

TIMING	HERBICIDE FORMULATION	BROADCAST RATE/ACRE AMOUNT OF FORMULATION	POUNDS ACTIVE INGREDIENT/A	REMARKS AND PRECAUTIONS
	sulfentrazone (Spartan DF) 0.75 lb ai/lb	5.3 oz	0.25	Based on the results of accumulated work in Georgia Spartan 4F has received 2 (ee) labeling providing for the application of Spartan 4F with a shielded sprayer within 7 days after transplanting but prior to weed emergence and cultivation.
	(Spartan 4F) 4 lb ai/gal	8.0 oz		
	sulfentrazone (Spartan DF) 0.75 lb ai/lb	5.3 oz	0.25	Tobacco transplants should be protected from Spartan 4F spray using an appropriately shielded sprayer. Apply Spartan 4F solution to provide coverage of all row bed surface excluding 4 inches on both sides of the tobacco transplants (8" band). Cultivate tobacco as-soon-as-possible and within 7 days of Spartan 4F application to provide slight incorporation and move treated soil around plants and to cover untreated press wheel track (8" band).
	+	+		
	clomazone (Command)3ME 3 lb/gal	2.0 to 2.66 pt/A	0.75-1.0	
POST TRANS-PLANTING (continued) - with hooded or shielded sprayer	carfentrazone (Aim EC) 2 lb ai/gal	0.8 - 1.5 fl oz	0.013 - 0.023 lb ai	Use Aim EC for postemergence control of many broadleaf weeds (including most morningglory species other than small flower) up to 4 inches high growing in between the rows of tobacco. Use higher rates when treating more mature weeds or dense vegetative growth. COVERAGE IS ESSENTIAL FOR GOOD CONTROL. Use adequate spray volume to achieve thorough coverage, but a minimum of 10 gallons of finished spay per acre is required. Use a quality crop oil concentrate (COC) at 1% v/v (1 gallon of COC per 100 gallons of spray solution). Do Not Allow spray solution to contact tobacco foliage or green stem tissue. Do Not Apply within 6 days of harvest. Do Not Apply more than 3.06 fl oz (0.48 lb ai) per acre per season.

Table 1. Tobacco Weed Control Alternatives (multiple pages)

TIMING	HERBICIDE FORMULATION	BROADCAST RATE/ACRE AMOUNT OF FORMULATION	POUNDS ACTIVE INGREDIENT/A	REMARKS AND PRECAUTIONS
LAYBY	napropamide (Devrinol) 50W	2 lb	1.0 - 2.0	These herbicides are applied following the last cultivation (usually 4 to 6 weeks after transplanting). Spray equipment should be set up with drop nozzles to direct the herbicide spray to the shoulders of the tobacco beds and middles. These herbicides will not control established weeds; therefore, middles should be free of any existing weeds prior to herbicide application. Irrigate with 1/2 inch water if no rain on Prowl occurs within 3 to 4 days. Do not spray in the buds of tobacco as plant injury may occur.
	pendimethalin (Prowl) 3.3E	1.8 - 2.4 pt	0.75 - 1.0	
	(Pendimax) 3.3 lb/gal	1.8 - 2.4 pt		
	(Prowl H20) 3.8 lb/gal	1.6 - 2.1 pt		
LAYBY (Continued from previous page) (for post emergence control of grasses)	sethoxydim (Poast) 1.5 lb/gal	1 - 1.5 pt	0.19	Provides selective broad Spectrum postemergence control of annual and perennial grass weeds. Poast does not control sedges or broadleaf weeds. Addition of a non-phytotoxic oil concentrate at 1 qt/A is required. Do Not apply within 42 days of harvest. Do Not apply to grasses under stress, such as stress due to lack of moisture or herbicide injury, as unsatisfactory control may result. Do not cultivate within 7 days before or 7 days after applying Poast.

Table 1. Tobacco Weed Control Alternatives (multiple pages)

	BROADCAST RATE/ACRE			
TIMING	HERBICIDE FORMULATION	AMOUNT OF FORMULATION	POUNDS ACTIVE INGREDIENT/A	REMARKS AND PRECAUTIONS
AFTER FIRST HARVEST - Post - Directed or Banded -	carfentrazone (Aim EC) 2 lb ai/gal	0.8 - 1.5 fl oz	0.013 - 0.023 lb ai	Aim EC may be applied with drop nozzles or other spray equipment capable of directing the spray to the target weeds and away from sensitive plant parts. Aim EC may be applied up to the maximum rate for the target crop for the control of larger weed sizes or weeds not controlled with lower use rates. **Directed spray after first priming** (Flue-Cured Tobacco Only) Aim EC may be applied as a directed spray application after the first priming in only flue cured tobacco only for the control of emerged and actively growing broadleaf weeds. Directed spray equipment should position nozzles a minimum of 3 to 4 inches above the soil, with nozzles directed underneath the crop canopy. Spray solution should be directed at the base of tobacco plants for minimal contact with foliage while maintaining maximum contact with broadleaf weeds that are at appropriate treatment size. Do not apply when conditions favor drift or wind is above 10 mph. Use Aim EC for postemergence control of many broadleaf weeds (including most morningglory species other than smaill flower) up to 4 inches high growing in between the rows of tobacco. Use higher rates when treating more mature weeds or dense vegetative growth. COVERAGE IS ESSENTIAL FOR GOOD CONTROL. Use adequate spray volume to achieve thorough coverage, but a minimum of 10 gallons of finished spray per acre is required. Use a quality crop oil concentrate (COC) at 1% v/v (1 gallon of COC per 100 gallons of spray solution). Do Not Allow spray solution to contact tobacco foliage or green stem tissue. Do Not Apply within 6 days of harvest. Do Not Apply more than 3.06 fl oz (0.48 lb ai) per acre per season.

TOBACCO WEED RESPONSE TO HERBICIDES

J. Michael Moore, Extension Agronomist - Tobacco

	PLANT BED & FIELD	FIELD APPLICATION											
		PRE-TRANSPLANT						POST TRANSPLANT			LAYBY		POST-DIRECTED
		SURFACE APPLIED	INCORPORATED										OR BANDED
	Poast + Crop Oil	Spartan Charge[1]	Com mand	Prowl	Dev-rnol	Tillam	Devrinol + Tillam	Dev-rinol	Com-mand	Poast + Crop Oil	Dev-rinol	Prowl	Aim EC
PERENNIAL WEEDS													
purple nutsedge	P	E	P	P	P	P	P	P	P	P	P	P	N
yellow nutsedge	P	E	P	P	P	F	F	P	P	P	P	P	N
ANNUAL GRASSES													
crabgrass	E	F-G	E	E	E	E	G	E	E	E	E	E	N
crowfootgrass	E	F	G	E	E	E	G	E	G	E	E	E	N
goosegrass	E	F-G	G	E	E	G	G	E	G	E	E	E	N
fall panicum	E	F-G	G	G	G	G	G	G	G	E	G	G	N
johnsongrass (seedling)	E	F	F	G	F	G	G	F	F	E	F	G	N
sandbur	G	P-F	F	G	-	G	G	-	F	G	-	G	N
Texas panicum	G	F	G	G	-	P	P	-	G	G	-	G	N
BROADLEAFS													
bristly starbur	P	F-G	P	P	P	G	G	P	P	P	P	P	N
Florida beggarweed	P	G-E	F-G	P	P	P	P	P	F-G	P	P	P	F
cocklebur	N	F-G		P	P	P	P	P		N	P	P	G
Florida pusley	P	F-G	F-G	E	G	E	E	G	F-G	P	G	E	
lambsquarters	N	E	F-G	G	G	G	G	G	F-G	N	G	G	E
pigweeds	N	E	P	G-E	G	G	G	G	P	N	G	G-E	E
prickly sida	N	P	G	P	P	F	F	P	G	N	P	P	
purslane	N	G-E	F-G	E	E	G	E	E	F-G	N	E	E	E
ragweed	N	P	F	P	F	G	G	F	F	N	F	P	F
smartweed	N	E	G	PF	P	P	P	P	G	N	P	PF	E
morningglory sp.	N	E	P	P	P	P	P	P	P	N	P	P	G-E

Key to response symbols:

G= E= Excellent control, weed kill 90% or above.
Good control, weed kill 80% or above.
F = Fair control, weed kill 70% or above.
P = Poor control, less than 70% control.
N= No Control If no symbol is given, weed response is unknown.

Ratings are based on average to good soil and weather conditions for herbicide performance.

Bermudagrass and rhizome johnsongrass cannot be controlled with presently labeled tobacco herbicides in the same growing season. However, control can be achieved with Roundup in the season prior to transplanting tobacco (check label for rates and application).

[1] Transplant into the Spartan treated bed surface without pushing additional soil from the bed.
Spartan should not be incorporated into the bed greater than 2 inches.
Do Not apply Spartan post-transplant over the top of tobacco as crop injury may occur.

TOBACCO DISEASE CONTROL

Paul Bertrand

Disease control in tobacco involves an integrated program of numerous practices. Useful practices include crop rotation, root and stalk destruction, nitrogen management, plant spacing, varieties, and chemicals.

CROP ROTATION

Crop rotation is a particularly useful practice in dealing with pathogens that live in the soil. Rotation causes pathogen populations to decline naturally in the absence of suitable food sources. The longer tobacco can stay out of a field, the more beneficial the program will be. In general, small grains and forage grasses are the best overall crops to rotate with tobacco. In the case of root-knot nematodes, selection of the best rotational crop depends upon which root-knot species are present. Cotton is a good choice where Javanese and/or peanut root-knot is present, but a poor choice where high levels of Southern root-knot are present. Corn, though always better than continuous tobacco, is not always ideal due to variation in how corn varieties respond to different nematode populations. Soybeans vary greatly in susceptibility to root-knot nematodes and it is fairly easy to select a variety that would be more beneficial in a particular case. As with other diseases, small grains and forage grasses work well. In most cases, even native weeds would be better than continuous tobacco.

NITROGEN MANAGEMENT

Excess nitrogen causes a nightmare of sucker problems and favors several diseases. Use the full amount of nitrogen needed to produce a top quality crop, but not a bit more. Even small amounts of excess nitrogen can result in a significant, usually negative response in tobacco.

PLANT SPACING

A field spacing of about 20-22 inches between plants has been shown to produce the best tobacco. Tighter spacing puts more plants per acre and restricts air movement between plants. Restricted air movement slows drying and increases suitable pathogen habitat by favoring both infection and spread of diseases. Increasing plant population by decreasing in-row spacing to compensate for loss from tomato spotted wilt virus is not recommended. Following such a practice would lead to increased sucker control problems every year and increased losses from blue mold, target spot, angular leafspot and hollow stalk in wet years. Reduced plant spacing will also lead to more rapid and extensive spread of tobacco mosaic virus.

EARLY STALK AND ROOT DESTRUCTION

This practice, also known in North Carolina as R-9-P for reduce nine pests, is very important. Root and stalk destruction as soon as possible after harvest reduces overwintering populations of pathogens infesting these plant parts. The root destruction part of the program also eliminates fall and winter suckers which feed infested roots and serve as sources for build-up of foliar diseases. Blue mold and viruses can carry over during a mild winter in these suckers.

The four steps involved in a good root and stalk destruction program are outlined below:

1) Cut stalks into small pieces with a rotary or flail mower as soon as possible after harvest.
2) Plow or harrow the stubble immediately after stalk cutting. Be sure to pull roots completely out of the soil.
3) Cross harrow the field two to three weeks after Step 2.
4) When roots are fully dried out and dead, plant a winter cover crop to reduce soil erosion.

VARIETIES

Resistant varieties are useful for control of some tobacco diseases. Growers should not rely on the same variety for disease control year after year. Pathogens can adapt through build up of initially minor species or races and in time overcome any variety. This has been clearly demonstrated for black shank and root-knot nematodes. Rotating varieties is a good idea and should slow down loss of resistance to black shank. Table 4 in the Variety Section of this book lists common tobacco varieties and their disease resistance properties.

Table 1. Common Tobacco Diseases and Various Control Practices

Disease	Rotation	Root & Stalk Destruction	Nitrogen Management	Plant Spacing	Varieties	Chemicals
Root-Knot	Yes	Yes	--	--	Yes	Yes
Black Shank	Yes	Yes	--	--	Yes	Yes
Blue Mold	--	Yes	Yes	Yes	--	Yes
Brown Spot	Yes	--	Yes	Yes	--	--
Fusarium Wilt	Yes	Yes	--	--	Yes	Yes**
Soreshin	--	--	--	--	--	--
Target Spot	--	--	--	Yes	--	--
Angular Leafspot	Yes	Yes	Yes	Yes	--	Yes*
Granville Wilt	Yes	Yes	--	--	Yes	Yes
Hollow Stalk	--	--	--	Yes	--	--
Tobacco Mosaic	Yes	Yes	Yes	Yes	Yes	--
Tobacco Etch	--	Yes	--	--	--	--
Potato Virus Y	--	Yes	--	--	Yes	--
Tomato Spotted Wilt Virus	--	--	--	--	--	Yes

Yes= Useful in control, though may not give total control;
-- = Not known to be useful in control.
Yes* = Recommended in some areas, but should not be relied upon in all situations.
Yes** = Nematode control practices reduce Fusarium Wilt.

BLUE MOLD

Blue mold caused by *Peronospora tabacina* is spread by spores carried long distances by wind. Ideal conditions for blue mold would be night temperatures above 50 ° F, day temperatures about 70 °F along with fog, rain or dew to keep leaves wet.

Long distance spore movements are tracked by the North Carolina Blue Mold Forecast System. This system can give up to 48 hours warning of blue mold spore movement. This information can be accessed via the world wide web at: http://www.ces.ncsu.edu/depts/pp/bluemold/

These forecasts may be used to trigger treatment or intense scouting depending on the level of risk each individual wishes to assume. These forecasts are useful to predict first movement of blue mold into an area. Once blue mold is present, local weather conditions should be used to make further treat/don't treat decisions.

Table 2. Blue Mold Control

Chemical and Formulation	Rate Per Acre Per Application	Remarks
FORUM™ fungicide	2 - 8 oz	Select Forum rate and spray volume/acre from table below. To be effective Forum requires total plant coverage. **FORUM™ fungicide** must be applied as a tank mix with another fungicide that has a different mode of action (**non-group 15** fungicides)

Weeks of Growth After Transplant	Rate of **FORUM™ fungicide** (oz of Product	Water Output (Gallons/Acre)
Recently Transplanted to 3 weeks after transplanting.	2	20
3-4 weeks after transplanting (Knee High)	3	40
4-5 weeks after transplanting (Waist High)	4	60
6-7 weeks after transplanting (Chest High)	6	80
7 weeks after transplanting and beyond (Shoulder height up to topping)	7	100

Note: *Above directions are for dilute sprays. If concentrate sprays are used, adjust rate and volumes proportionally, e.g. for mist blows, use 2X concentrate and ½ the spray volume.*

Begin applications when the **Blue Mold Advisory states that conditions favor development of blue mold**, and before the onset of disease. Continue applications on a 5-7 day spray schedule until weather conditions favoring infection and sporulation decrease. Discontinue sprays when and if the threat of blue mold subsides. **Restrictions (Field Applications): DO NOT** exceed 8 oz/acre per application. **DO NOT** exceed 30 oz/acre of **FORUM™ fungicide** per season. **Tobacco may be harvested the day of the last application, after spray has dried.**

Chemical and Formulation	Rate Per Acre	Remarks
Actigard 50 WG	0.5 oz	Apply Actigard any time after tobacco reaches 18 inches high. Make a second application 10 days later

Actigard is not a traditional fungicide. Actigard induces a disease resistance mechanism in some plants including tobacco. It takes 5-7 days after an Actigard application for the disease resistance process to become fully effective.

BLACK SHANK

Black Shank is caused by the fungus *Phytophthora parasitica* var. *nicotianae*. DO NOT GROW TRANSPLANTS IN ANY FIELD WHERE BLACK SHANK IS KNOWN TO HAVE OCCURRED. METHYL BROMIDE WILL NOT ERADICATE THIS FUNGUS OR GUARANTEE DISEASE FREE TRANSPLANTS. Black shank infection is favored by wet spring weather. Highest losses then occur during dry summer periods as rotted roots fail to keep up with water demands. Typically black shank results in extensive root rotting, pith disking and decomposition, and blackening on the outer surface of the stalk. Resistant varieties show less obvious symptoms in the pith.

USE ROTATION

One of the best control measures for black shank is rotation. Keep tobacco out of fields with a history of black shank as long as possible. Alternate year production provides little or no benefit. Three or more years rotation will provide a consistent moderate to high level of benefit.

Table 3. Chemical Control of Black Shank[1]

Chemical and Formulation	Rate Per Acre	Pounds Active Ingredient	Remarks
(mefenoxam) [2]		(1 + 0.5 - 1.0)	
Transplant Water (TPW)			**Transplant Water:** For best results mix in a tank separate from transplant water and meter into planter furrow with calibrated nozzles.
Ridomil Gold	(4-8 oz/A)		
After Transplanting			**Broadcast-Incorporate** prior to setting.[3] Mefenoxam may be applied to the beds at first plowing if heavy rainfall (>1") occurred since the PPI/TPW treatment.
Ridomil Gold	(1 pt PPI + 0.5-1 pt layby)		
Ultra Flourish	(1 qt PPI + 1-2 pt layby)		Apply mefenoxam at layby using two drop nozzles per row. Direct spray to bed. Follow with layby plowing.

[1] Where root-knot nematodes and the black shank fungus occur in the same field, use a preplant fumigant for nematode control.

[2] Additional mefenoxam may be applied at any plowing if >1" of rainfall has occurred since transplanting or field history warrants.

[3] Mefenoxam should be applied 48 hours prior to or within 24 hours after transplanting. Any delay between treatment and transplanting can result in chemical loss by leaching or breakdown.

FOLIAR APPLICATIONS OF RIDOMIL GOLD/ULTRA FLOURISH FOR BLACK SHANK CONTROL ARE ILLEGAL AND USELESS!

1) Very little mefenoxam is taken up by leaves.
2) Almost none of the mefenoxam taken up by a leaf moves out of that leaf.
3) All mefenoxam movement in plants is upward away from the roots where the black shank fungus enters.

USE RESISTANT VARIETIES

Seventy five percent of the tobacco now grown in Georgia is rated as having high black shank resistance. This is based on the presence in these varieties (NC 71, NC 72, NC 297, NC 196, Speight 168, etc.) of a single gene (Php gene) giving total resistance to pathogen race O. A statewide survey conducted in 1994 found a second race

designated pathogen race 1 at very low levels but scattered all over the Georgia tobacco production area. SOME OF THE NEW PATHOGEN RACE O RESISTANT VARIETIES HAVE LITTLE OR NO RESISTANCE TO PATHOGEN RACE 1. Black shank is becoming common in these varieties and in all cases has been found to be pathogen race 1. CONTINUOUSLY GROWING THESE VARIETIES HAS SELECTED AND BUILT UP PATHOGEN RACE 1. If any black shank is seen on a Php gene variety select subsequent varieties based on FL 301 resistance.

The only way to minimize losses is:

I. ROTATE OUT AS LONG AS POSSIBLE
II. USE A SOUND CHEMICAL CONTROL PROGRAM (TABLE 3.)

BACK-UP ANY FL 301 RESISTANT VARIETY WITH A SOUND MEFENOXAM PROGRAM(Table 4.)

Table 4. Control of Black Shank with Resistance and Ridomil[1]

Variety	Black Shank Rating	Final % Black Shank	
		Check	Ridomil Gold[2]
K 326	L	51.1 a	26.5 a
GL 737	M	30.4 b	11.2 bc
NC 297	M	26.8 b	13.6 b
Spt H 20	H	19.4 bc	6.8 bc
NC 71	H	17.2 c	3.9 c

[1]Ridomil was applied at 1 pt/A at transplanting + 0.5 pt/A at 1st plowing + 0.5 pt/A at layby.
[2]Reduction in black shank with Ridomil for each variety is significant (p=0.05).

BROWN SPOT

Brown spot, caused by *Alternaria alternata*, is a foliar disease that usually develops from mid season to harvest. It begins in the lower leaves and works up the plant. Brown spot is favored by wet weather, excess nitrogen and tight plant spacing. Fungicides are not effective for brown spot control.

FUSARIUM WILT

Fusarium wilt, caused by *Fusarium oxysporum f.sp. nicotianae*, is not a common problem. It is a serious problem where it occurs. Symptoms usually develop on one side of the plant with distinctive leaf yellowing and drying. Peeling the outer bark will reveal brown to black discoloration in the woody stem cylinder. Initially there is little root rot. The best control for Fusarium wilt is to abandon an infested site. Where this is not practical long rotations with forage grasses or small grains are recommended. Root-knot nematodes will make Fusarium wilt much worse. In Fusarium infested sites, treatment with multi-purpose fumigants and RKN resistant varieties are useful.

SORESHIN

Soreshin is caused by the fungus *Rhizoctonia solani* AG-4 and usually develops during the first 4-6 weeks after transplanting. This disease is favored by rough handling transplants and cool, wet weather. Sand blasting stems in wind storms often leads to soreshin. There is no chemical control for soreshin.

TARGET SPOT

Target Spot is frequently seen in plantbeds. It caused damage in Georgia tobacco fields for the first time in 1991. It is caused by races of *R. solani* in group AG-3 which are different from those causing soreshin.

In plantbeds and greenhouses the symptoms are small brown greasy looking spots. In the field it occurs first on lower leaves and in very wet seasons can move to some extent up the plant. Symptoms begin as small spots similar to what is seen in plantbeds. On field tobacco the spots enlarge, become somewhat circular, light colored, and papery with a target like pattern of concentric bands. Target spot is very difficult to distinguish from brown spot by symptoms alone. Target spot is favored by long periods of leaf wetness and continuous moderate temperatures (68°F - 86°F). These are similar to the conditions that favor blue mold. The *R. solani* races that cause target spot have always been present in our soils. The growing season weather will regulate future occurrence of target spot.

Table 5. Application of Quadris for Target Spot

Chemical and Formulation	Rate Per Acre	Pounds Active Ingredient	Remarks
(azoxystrobin)		(0.1-0.2 lb)	Make a single application at the first sign of target spot. Full plant coverage is necessary. Use drop nozzles as needed.
Quadris F	(6-12 oz.)		

ANGULAR LEAFSPOT

Angular leafspot, caused by *Pseudomonas syringae* pv. *tabacina*, is a bacterial disease favored by wet weather, excess nitrogen, excess lime (high pH), low topping and tight plant spacing. Any handling of plants in infected fields during wet periods will spread the disease. Streptomycin sprays have been recommended in various sources for angular leafspot control. The value of these sprays is questionable. It is not economical to apply them every year, yet bacterial diseases become very hard to control once they are present in the field. The disease increases during wet weather. A warm, dry period that would dry the field out and allow for spraying usually halts spread of the disease. The program usually recommended is a solution containing 200 ppm Streptomycin applied at 25-35 gallons per acre every 7 days.

GRANVILLE (BACTERIAL) WILT

Granville wilt, caused by *Ralstonia solanacaerum*, is not a common problem in Georgia. However, it is a very serious problem for the growers who have it. Tobacco variety resistance to Granville wilt is given in Table 4. of the Variety Section of this book. Corn, cotton and peanuts are poor choices for rotational crops in fields where Granville Wilt is a problem. Use soybeans, small grains or weeds in these fields. In fields with a known history of Granville wilt use a multi-purpose fumigant such as Chlor-o-pic at 3 gpa or Telone C-17 at 10.5 gpa.

Above ground symptoms of Granville Wilt are virtually identical to those of Fusarium Wilt. In early stages before secondary deterioration begins, internal symptoms are somewhat different. Granville wilt usually shows

a general darkening. Fusarium wilt will show dark streaks in the vascular tissue while the pith remains white. A way to verify Granville wilt is to suspend one end of a stem section in warm (not hot) water for two to 10 minutes. Set the stem section so that one end is about one inch under water, two inches or so above the bottom of the water reservoir. If Granville wilt is the problem, a distinct cloudy fluid or material will usually flow out of the underwater stem end.

HOLLOW STALK (Soft Rot, Barn Rot)

These diseases are caused by the bacteria, *Erwinia carotovara* var. *carotovora*. Disease is favored by tight plant spacing and wet weather, particularly during topping season. When the disease is present, tops and suckers should not be pulled while the plants are wet. High rates of contact sucker control chemicals can contribute to disease in wet seasons. When disease is present, harvest should be avoided while the leaves are wet. Packing wet infested leaves into boxes or racks can result in further losses from barn rot.

TOBACCO ETCH VIRUS (TEV) and POTATO VIRUS Y (PVY, VEIN BANDING)

TEV and PVY are aphid transmitted viruses. The virus is carried as a contaminant on the mouth parts. The virus is picked up in feeding on infected plants. Virus can be transmitted to a healthy plant if an aphid feeds as briefly as 10 seconds. Nearly all the virus particles the aphid carries are wiped off of its mouth during the first feeding after picking up virus. Insecticide sprays will not help control these or other aphid borne diseases.

TOMATO SPOTTED WILT VIRUS (TSWV)

TSWV first appeared in Georgia tobacco in 1986. Leaf symptoms are quite variable and include necrotic banding along and around the main veins, target-like ring spots, leaf twisting with symptoms on only one side of the midrib, and/or general necrosis of bud leaves. Stalk symptoms are also somewhat variable. Early in the season the lower stalk may show a dark, somewhat sunken, area resembling soreshin. Near topping time, parallel black necrotic bands (curved or straight) may be seen moving down the stalk from infected leaves. These bands are different from the usual russet streaks that come form contact sucker control products. Large plants may develop symptoms (stalk and leaf) on one side or the entire stalk my become necrotic causing a rapid wilt, leaf yellowing and death. Near harvest, stalks of infected plants seem to blacken and rapidly deteriorate.

TSWV is spread by thrips. In tobacco the major carrier of TSWV is the tobacco thrips *Franklinella fusca*. TSWV must be picked up by juvenile thrips feeding on infected plants. TSWV may be spread by both juvenile and adult thrips. In tobacco, adult thrips are believed responsible for most infection.

Weeds provide the source of TSWV. About 30 species of common broad leafed weeds have been found to host TSWV in Georgia. Ten to 12 weed hosts of TSWV are present any time of the year. Tobacco thrips acquire the virus in native weed communities and bring it to tobacco as they move about in search of feeding sites. Weeds near tobacco may be more important than weeds further away but thrips are active flyers and move whatever distance is necessary to find suitable habitat.

SPOTTED WILT MANAGEMENT

I. TRANSPLANT DATE

The response to transplant date varies from year to year and from farm to farm in any particular year. No single best time to plant or not plant can be identified. However, in combining the results of all transplant date trials the data shows **the risk of most spotted wilt is twice as great in tobacco planted before 7 April as compared to planting after 7 April.**

II. SYSTEMIC INSECTICIDES

Admire 2F (imidacloprid) was labeled for TSWV suppression in 1997. In over 125 trials we have seen about 30% reduction of spotted wilt with Admire 2F. Recently new products such as Platinum/T-Moxx (thiamethoxem) have also been found effective. Admire 2F was replaced by Admire Pro 4.6 SC in 1996. There are several generic 2F formulations of imidacloprid that have been tested.

TABLE 6. APPLICATION OF SYSTEMIC INSECTICIDES IN PLANT HOUSE

Chemical and Formulation	Rate per 1000 transplants	Remarks
Admire Pro 4.6 SC	0.7 - 0.9 oz	Apply ALL listed products as a spray-on/rinse-off tray drench. For best results apply in the morning when plants are wet with dew. In the afternoon lightly pre-wet plants before treatment. Spray on product and immediately rinse it off leaves into the media ball where it is available for root uptake.
Generic imidacloprid 2F formulations (Alias, Couraze, Imia, Macho, Nuprid, Torrent)	1.5 - 2.0 oz	
Platinum 2SC / T-Moxx 2SC	1.3 oz	
FLOAT BED HOUSE: Apply product of choice 2-4 days prior to transplanting T-RAIL HOUSE: Apply after the last irrigation; 6-12 hours before transplanting		

TABLE 7. APPLICATION OF SYSTEMIC INSECTICIDES IN TRANSPLANT WATER FOR BARE ROOT PLANTS

Chemical and Formulation	Rate per 1000 transplants	Remarks
Admire PRO	0.8 - 1.1 oz	Apply to transplant water with thorough mixing. Where a separate front mounted tanks are used to meter solution to transplanter provide agitation. Where nurse tanks are used with pre-mixed solutions allow 5 minutes agitation after adding chemical before pumping into planter barrel.
Generic imidacloprid 2F formulations (Alias, Couraze, Imida, Macho, Nuprid, Torrent)	1.8 - 2.4 oz	

III. ACTIGARD 50WG

Approval for use of Actigard in plant houses and plant beds has been granted through a special local needs registration. Product labels for this use must be acquired after accepting a Waiver of Liability and Indemnification Agreement on the Syngenta Farm Assist web site.

Under this registration the user of the product assumes ALL liability.

Acquiring a Label for Actigard™ 50WG Use in the
Plant House / Float House And/or Field Bed
to
Suppress Tomato Spotted Wilt Virus

http://www.farmassist.com./

ACTIGARD™ 50WG is a Syngenta product.
Use in the plant house / float house and field beds for TSWV suppression is not covered on the Section 3, Federal label.

Although Syngenta does not recommend the use of Actigard for TSWV they allow growers to assume all risks associated with the use of Actigard on tobacco transplants in exchange for signing a Waiver of Liability and Indemnification Agreement.

The University of Georgia Cooperative Extension recommends the use of Actigard as a part of the Tomato Spotted Wilt Virus Management Plan.

To sign a Waiver of Liability and Indemnification Agreement and receive a copy of the
ACTIGARD™ 50WG label with which to make the application each prospective user should follow the instructions on the FarmAssist website to the waiver and agreement.

Go to: http://www.farmassist.com./

At the upper, left hand, corner click Sign In or Register if you have not yet registered on this site.

Next screen, complete the Demographic Information requested and click "I Agree".

Next screen is the Home Page. Go to the Products tab in the column on the left side of the page.

Click Syngenta Crop Protection, then Special Labels.

Next screen, just under the statement "If searching for indemnified labels, click here" Click "here"

Next screen, from the drop-down box choose your state, then from the next select Actigard 50WG.

Next screen, from the drop-down box select Tobacco (Flue-cured) and Click Submit.

Next screen, READ the Waiver of Liability and Indemnification Agreement, Click "I Accept"

After clicking "I Accept" you will then see a copy of the Actigard 50WG Section 24(C) Special Local Need Label needed to make the application to tobacco seedlings in the greenhouse for Tomato Spotted Wilt Virus suppression. This labeling must be in the possession of the user at the time of pesticide application.

You may print a copy of the label for your personal use, but it is not to be shared with others as you have agreed by name to the Waiver of Liability and Indemnification Agreement and you have assumed ALL liability for the use of this product.

TABLE 8. APPLICATION OF ACTIGARD TO TRANSPLANTS

Chemical and Formulation	Rate
Actigard 50WG	1.0 oz per 100,000 plants

- Spray Actigard over plants in houses or beds 5-7 days before transplanting.
- Potential for plant injury depends largely on plant size at the time of treatment.
- DO NOT treat until plants are large enough to transplant

USE ACTIGARD WITH IMIDACLOPRID IN A JOINT PROGRAM.

USE ACTIGARD VERY CAREFULLY:

1. Delay treatment until seedlings are field ready.

2. DO NOT exceed 1.0 oz/100,000 plants

3. DO NOT treat plants with Actigard a second time.

4. DO NOT hold Actigard treated bed plants more than a day after pulling. Treated plants which are held do not perform as well as fresh plants. **DO NOT** allow treated plants in trays to dry out on the trailer.

5. Place unused trays back in floatwater or sprinkler water unused trays each day.

5. Use plenty (100 gal/A) of transplant water.

Even when Actigard is used carefully some plant damage in the form of slow early season growth may occur. How well plants recover depends on field environment the first few weeks after transplanting.

1. Use transplant water.
2. DO NOT plant in dry soil; pre-wet beds if necessary
3. AVOID transplanting on dry windy days
4. Irrigate before plants become stressed.

TSWV Management Plan for Tobacco

1. **Transplant after April 7.**
   Data indicate twice as great a chance of high incidence of disease prior to this date.

2. **GREENHOUSE PLANTS**
   a. **ADMIRE PRO @ 0.7 - 0.9 oz/1000 tray cells as per Growers Guide**
   or Generic Imidacloprid 2F @ 1.5 - 2.0 oz/1,000, tray cells
   or Platinum/T-Moxx @ 1.3 oz/1,000, tray cells

      i. **Apply and rinse-off foliage 2 to 4 days before transplanting**
         - **Use 10 to 12 gallons of solution per 100,000 cells for application and again for rinse-off of the residue.**

      ii. **T-rail plants: avoid excessive irrigation after application.**
         - **Water only to maintain plants. Trays should not drip.**

3. **BARE ROOT PLANTS – (Apply chemical in transplant water as per Growers Guide)**

   a. **ADMIRE PRO @ 0.8 - 1.1 oz/1000 plants**
   or Generic Imidacloprid 2F @ 1.8-2.4 oz/1,000 plants

4. **ALL PLANTS (Plant house / Float house and Bare Root Plants)**

   a. **ACTIGARD @ 1.0 oz/ 100,000 plants as per Growers Guide**

      i. **apply ACTIGARD only to plants large enough and old enough to be transplanted. Use 10 to 12 gallons of solution per 100,000 cells for application.**

      ii. **apply ACTIGARD 5-7 days before expected transplant date.**

         1. **ACTIGARD treatment is effective and plants may be used for at least 10 to 14 days after treatment.**

         2. **DO NOT RE-TREAT PLANTS WITH ACTIGARD**

         3. **DO NOT HOLD ACTIGARD treated plants overnight after removal from beds or plant houses / float houses.**

5. **Pre-water field beds during periods of drought and/or wind before transplanting.**
   A day or two delay in planting is better than planting ACTIGARD treated plants in dry beds. ACTIGARD treated plants do not tolerate stress well.

6. **USE ADEQUATE TRANSPLANT WATER TO ENCOURAGE PLANT ESTABLISHMENT**

7. **AVOID Transplanting on hot, dry, windy days.**

ROOT-KNOT NEMATODE

Root-knot nematode (RKN) is the major nematode problem facing Georgia tobacco growers. Control of RKN is becoming more complicated each year. A virtual complete shift to varieties resistant to race 1 & 3 of Southern RKN has resulted in selection of previously minor species and races of RKN and elevating these to major pests. As a result, Javanese, race 2 and/or 4 of Southern and, to a lesser extent, peanut RKN are now major tobacco pests. There are no varieties resistant to these species or races leaving root destruction, crop rotation and chemicals as the only control options. Control of Javanese and peanut RKN must be more thorough than with the traditional Southern RKN because as individuals these species are much more damaging to tobacco.
ROOT AND STALK DESTRUCTION SHOULD BE DONE THOROUGHLY.

CROP ROTATION

In selecting rotational crops the grower must know which RKN species and races are present. For example, cotton is a good rotational crop for Javanese and Peanut RKN, but a poor one for Southern RKN. Soybeans vary widely in their resistance to various RKN species. Choice of best variety depends upon the specific RKN present.

NEMATODE SAMPLING

The only way to know what is present is to sample the field. Samples taken in the fall or winter especially following crops other than tobacco are almost worthless. When taking nematode samples, follow the guidelines outlined below:

1) Sample during the tobacco growing season (15 June - 15 July).
2) Sample moist soil, Do not add water to dry samples.
3) Sample the entire field.
4) Sample problem areas separately from non problem areas.
5) Keep samples in a portable cooler between collection and delivery to the County Extension Office. This will keep the samples from overheating which kills and rots nematodes very quickly.
6) Sample early in the week so samples will arrive at the lab in Athens the same week as collected.
7) Fill out the nematode sample form completely including tobacco variety information.
8) Check tobacco roots for nematode galls. These can be used to determine RKN species present. Knowing which kinds are present is much more useful than knowing how many.
9) Sampling crops other than tobacco the year before growing tobacco is generally a waste of time.

ROOT EXAMINATION

Root examination is very useful in evaluating nematode problems. From mid June until mid July, dig up a few stalks at various points in the field and look at the roots for galls. If RKN is present some galls may be seen on any variety regardless of what chemical nematicide is used. However, if root systems are consistently 25% or more galled, some loss is occurring and the control program should be reviewed. Always look at root systems in areas of any field where the tobacco does not grow well. Once the RKN population has been defined, the best rotational crops and chemical nematicide can be chosen.

ROOT-KNOT NEMATODE SPECIES IDENTIFICATION

The Extension Nematology Lab has technology to enable accurate identification of RKN species. The charge for this procedure is $35 per sample. The procedure is expensive so growers taking advantage of this service are asked to:

A. Use it only where reasonable suspicion of a problem exists (numerous galls on RKN resistant varieties).
B. Keep good records so as to not continually re-sample fields where problems have been identified. Nematode populations vary with crop history and season, but they do not go away.
C. Handle samples for root-knot nematode species identification through the county agent as with conventional nematode samples. Sampling involves mid-June to mid-July collection of plant roots. Samples are to be collected in the following manner.

1) Map out the field and dig rather than pull up sample plants.
2) Gently shake off most soil.
3) Select for testing plants with moderate to severely galled root systems that show NO sign of secondary rotting or gall breakdown. The test requires live female nematodes to be present in the galls.
4) Collect specimen plants from several areas in a field. Take a separate sample for each 10 acre block in a field.
5) Place galled roots (tops should be cut off) in plastic bags containing moist field soil and store in a cooler. It is not necessary to send the whole root system. Individual roots with galls on them are good enough. Clip roots rather than pulling roots apart to avoid stripping or damaging root galls. DO NOT ADD WATER.
6) Do not allow samples to heat or dry out.
7) Collect samples early in the week (Monday or Tuesday) so they can be shipped and received in the same week.
8). Call ahead to the lab to notify them root samples are being sent. More immediate processing is needed as compared to ordinary soil samples.

For information on Sampling for Nematodes / Charges and Fees visit the Nematode Assay Results System Webpage http://www.ciids.org/nars/

Contact Information for Nematology Laboratory

Ganpati B. Jagdale, Ph.D.
Extension Nematology Laboratory
Department of Plant Pathology
University of Georgia
2350 College Station Road
Athens, GA 30602

Phone: (706) 542-9144
Fax: (706) 542-5957
e-mail: gbjagdal@uga.edu

ROOT-KNOT NEMATODE CHEMICAL CONTROL

Table 10. Fumigant Nematicides

Chemical and Formulation	Rate Per Acre	Rate Per 100 Ft. of Row		Remarks
1-3D (Telone II)	42" Row Treatment	cc	fl ozs	Inject 8 inches deep on the flat or 4-8 inches below top of a high wide bed. Seal by bedding or dragging. Wait 3 weeks between application and setting. Break bed open 1-2 days prior to setting.
	6 gals			
Pic Plus (Chloropicrin 86%)	48" Row Treatment	184	6.2	
	4 gals			

* A fumigant nematicide is recommended when nematode damage potential is moderate to high, or when either Javanese (*Meloidogyne javanica*) or Peanut (*M. arenaria*) root-knot nematode is known to be present, or when either Fusarium wilt or black shank is known to occur in the field.

** Multipurpose fumigants such as Telone C-17 or Telone C-35 are also effective. These products are more costly than Telone II and only provide cost effective disease control when Granville wilt is also known to occur. In Georgia, multipurpose fumigants have never shown a consistent benefit for black shank control beyond the reduction in black shank associated with root-knot nematode control.

*** Pic Plus (chloropicrin 86%) applied at 4 gallons per acre will provide excellent control of root-knot nematode (rkn) but with quicker resurgence or rebound of rkn in the tobacco root systems in mid to late season than is seen with Telone II. No additional benefits from Pic Plus such as black shank control should be expected. Growers with fields with black history should follow recommended black shank programs involving Rotation, Resistance and chemical controls should be followed in addition to the use of Pic Plus for nematode control.

SOIL FUMIGATION Proper timing for application of soil fumigants is anytime between November 1 and March 1. Soil conditions at time of application are far more important than when or how deep the application is made.

APPLY WHEN:

1. November 1 - March 1
2. Soil is damp (not wet).
3. Air temperature is >60^{0}F.
4. Weather forecast calls for 3-5 days of warm sunny weather.

RESISTANT VARIETIES

SOUTHERN ROOT-KNOT NEMATODE: races 1 & 3:
The root-knot nematode resistance in tobacco is specific for races 1 and 3 of southern root-knot nematode.

JAVANESE ROOT-KNOT NEMATODE:
There are three new varieties (CC 27 & CC 37) with southern root-knot nematode resistance and added genes for resistance to javanese root-knot resistance. These varieties do not have a high black shank resistance to all races of the pathogen.

One variety (PVH 2275) is available with resistance to *M. arenaria* (Peanut), but none are available with resistance to southern root-knot nematode races 2 and 4. For a listing of varieties resistant to races 1 and 3 of southern RKN refer to Table 4 in the Variety Section of this book.

SOIL FUMIGATION EQUIPMENT

Paul E. Sumner

Growers facing a high potential for nematode damage in tobacco should consider using fumigants. There are two application methods for soil fumigants: (1) broadcast application, where chisel shanks are spaced every 12 inches and the point of injection 12 to 30 inches below the soil surface. (2) row application (the most commonly used method) where the placement of the fumigant is the same depth as for broadcast application but only one or two outlets are used per row.

EQUIPMENT

Application systems can be either PTO or electric pumps. A PTO or electric pump draws fumigant from the tank and pumps it into the distribution manifold. Excess fumigant is diverted back to the tank through a by-pass valve. Flow rate is regulated by metering discs located at each shank outlet and by the line pressure, (Do not exceed 25 psi) which is regulated by the bypass valve adjustment. When the flow to the shanks is stopped, all of the chemical is bypassed to the tank. A check ball screen should be placed between the hose and the metal tube to the injection shank. This will minimize end row drips and prevent clogging of the orifice plate.

COMPATIBLE MATERIALS

Some materials may have a violent reaction when coming in contact with a particular soil fumigant. Listed are some materials compatible and not compatible with fumigants.

COMPATIBLE: HD polyethylene, nylon, Teflon, Viton, stainless steel, mild steel, brass, copper, black iron and cross-linked polyethylene.

NOT COMPATIBLE: polypropylene, rubber, plastic, aluminum, magnesium, zinc, cadmium, galvanized steel, fiberglass, EPDM, Nuna-N, neoprene and PVC.

SUPPLIERS OF EQUIPMENT

Pearman Engineering Company
Chula, Ga. 31733
912-382-9947

Harrell Equipment Co.
Pelham, Ga. 31779
1-800-673-6369

Reddick Equipment Co., Inc.
Williamston, NC 27892
919-792-1191

Van's Equipment Co.,Inc.
Moultrie, Ga. 31768
912-985-1101

CALIBRATION

Applicators should always be calibrated. Use the Georgia Extension Service Circular 683 titled, Calibration Method for Hydraulic Boom and Band Sprayers and Other Liquid Applicators, to calibrate these units.

Always calibrate with clean water because fumigants are very corrosive. Fumigant applicators can be calibrated using the procedure for a conventional sprayer (previous section). Make certain to covert fumigant rates to water rates prior to the calibration. The conversion factor for Telone II is 1.1. Telone C-17 has a conversion factor of 1.13. Water rate = Fumigant rate multiplied by conversion factor.

If application rates are given in rate per 100 feet of row, simply mark off 100 feet and measure the time to travel with equipment in operation that distance. Next, with equipment in a stationary position collect in ounces flow from the outlet(s) for each row for the time to travel the 100 feet. Adjust the desired rate per 100 feet of row by multiplying by the conversion factor. If the amount collected is different from the desired rate, either change orifice plate or pressure setting.

When selecting shank or row spacing, care should be taken not to apply more fumigant than the recommended broadcast rate. Table 1 lists calculated broadcast rate based on row spacing with flow rate per 100 ft of row held constant.

Orifice disc selection for PTO and ground driven models can be determined from regular spray nozzle manuals such as Spraying Systems or Delevan. The pressure ratings are listed for 5 psi or higher.

Telone II is a fumigant that requires the use of PPE when loading and applying this product. Therefore it is recommended when calibrating Telone II application equipment water should be used. Water is less dense than Telone II. To correct for Telone II when using water to calibrate a conversion factor of 1.1 should be used.

Table 1. Broadcast Rate of Telone II Based on 184 cc or 6.2 fl. ozs. per 100 ft. of Row at Various Row Spacings. The Water Rate is 202.4 cc or 6.8 fl. ozs. per 100 ft. of Row.

Row Spacing (inches)	Telone II (GPA)	Water (GPA)*
20	12.6	13.9
22	11.4	12.6
26	9.7	10.7
30	8.4	9.2
36	7.0	7.7
38	6.6	7.3
40	6.3	6.9
42	6.0	6.6
44	5.7	6.3
46	5.5	6.0
48	5.3	5.8

*Water rates obtained by multiplying Telone II rate by 1.1.

MAINTAINING EQUIPMENT

Always conduct periodic checks of the systems for leaks. Each year make a practice to replace hose lines and tanks seals. Check valves, strainers, orifices and pressure regulators should be cleaned and in working order.

Cleanup and maintenance programs are much more important when fumigants are used than when less corrosive chemicals are used, even when sprayer components are made of the more corrosive resistant material. Diesel fuel or kerosene is a good material to use for cleaning machinery after applying fumigants. After fumigant applications, always flush your system with diesel fuel and fill pump with new motor oil.

INSECTS ON TOBACCO

David C. Jones

SOIL INSECTS

WIREWORMS

Wireworms, the most damaging soil insect pests of tobacco, are present in the soil at transplanting. They damage tobacco by feeding and tunneling in the below ground portion of roots and stems. Their feeding and tunneling may kill or stunt young plants and open up plants to soil-borne diseases. Stunted plants result in irregular and uneven stands. An uneven stand makes it more difficult to manage tops, suckers and insects. Because wireworms overwinter in the soil, they are usually more abundant in fields that follow crops, such as corn, soybeans, small grains, peanuts, sweet potatoes, pasture, and tobacco. There is no easy way to sample fields for wireworms prior to transplanting. Rescue treatments are nonexistent. Preplant soil applied insecticides are highly recommended for control of these insects (Table 1). For best results the insecticides must be incorporated immediately after they are applied. Imidacloprid (Admire 2F) or thiamethoxam (Platinum 2SC) applied as a foliar drench in the greenhouse prior to transplanting or in the transplant water gives good control.

MOLE CRICKETS

Mole crickets, sometimes called "ground puppies" and "cricket moles", make small, raised, mole-like trails as they burrow just under the soil surface. They damage newly set transplants by feeding on the roots and stems, often cutting them off near the surface of the soil. This damage is often mistaken for cutworm damage. Mole crickets feed at night and are especially damaging after a rain. When a field has a history of mole crickets, it is recommended that a preplant soil applied insecticide be used. In the past transplant water treatments have not given satisfactory control of mole crickets. However, imidacloprid (Admire 2F) applied as a foliar drench in the greenhouse prior to transplanting or in the transplant water gives good control. During the first month after transplanting, fields should be checked twice each week and on the very next day after a rain for mole cricket damage. If a preplant soil applied insecticide was not used and mole crickets become a problem, a grower has only one option - plow the field several times. Insecticidal baits, such as Dylox or Proxol 80 SP mixed with cornmeal have preformed well, however, these insecticides and many others are no longer labeled for use on tobacco.

CUTWORMS

Cutworms feed primarily at night or on cloudy days. They cut off small plants just above the soil surface and occasionally, cut off individual leaves. During the day, they hide beneath the soil surface at the base of damaged plants, or under soil clods and vegetative debris. On larger plants, cutworms may be found hiding on top of the soil under the bottom leaves. Cutworm problems are not easy to predict. However, the fields most likely to be infested are those that were weedy the previous fall and winter and were not plowed until just before bedding and transplanting. Low areas in a field with heavier soils are also places where cutworms may be a problem. Fields should be checked twice each week during the first month and treated with a recommended insecticide when five percent of the plants are damaged. Preplant soil applied insecticides, such as chlorpyrifos (Lorsban 4E and Lorsban Advanced) and ethoprop (Mocap 6EC), listed in Table 1. have not given good control of cutworms, based upon on-farm research conducted in the last eight years. See Table 2. For best results spray acephate (Orthene 75S or 97 PE) over the top of the plants, using one pound or 12 ounces respectively, per acre in 25 to 50 gallons of water. When acephate (Orthene 75S or 97 PE) is used in the transplant water, cutworms are usually not a problem. Although not labeled for cutworms, imidacloprid (Admire 2E) and thiamethoxam (Platinum 2 SC) have given adequate control of granulate cutworms.

Table 1. Control of Soil Insects in Tobacco Prior to Transplanting

INSECT	CHEMICAL AND FORMULATION[1]	PRODUCT RATE/ACRE	LBS AI/A	REMARKS AND PRECAUTIONS
Mole Crickets	bifenthrin		0.0625-	Apply bifenthrin as a pre-transplant broadcast application incorporated into the top 4" of the soil and no more than 0.2 lbs a.i./A per season.
	(Brigade 2EC)	4-6.4 oz	0.10	
	chlorpyrifos		2 - 3	
	(Lorsban 4E, Pilot 4E, Chlorfos 4E)	2 - 3 qts		
	(Lorsban Advanced)	2 qts		
	ethoprop		6-12	
	(Mocap 6EC)	1 - 2 gals		Apply broadcast to the soil surface one week before transplanting and mix into the top 3-6 inches of soil immediately.
	(Mocap Gel)	1 - 2 gals		
Wireworms	bifenthrin		0.0625-	Apply all insecticides to the soil surface 1-2 weeks before transplanting and mix into the top 3-6 inches of soil immediately. Bifenthrin can also be applied at these rates as a transplant water treatment instead of a broadcast application. Broadcast treatment for wireworm control only. Use 1-2 gallons of Mocap 6EC or Gel for both nematode and wireworm control.
	(Brigade 2EC)	4-6.4 oz	0.10	
	carbofuran		6	
	(Furadan 4F)	1.5 gals		
	chlorpyrifos		2 - 3	
	(Lorsban 15G, Pilot 15G, Chlorfos 15G)	13.5 - 20 lbs		
	(Lorsban 4E, Pilot 4E, Chlorfos 4E)	2 - 3 qts		
	(Lorsban Advanced	2 qts		
	ethoprop		2	
	(Mocap 6EC)	1.33 qts		
	(Mocap Gel)	0.33 gal		

Table 2. Control of Soil Insects in Tobacco at Transplanting

INSECT	CHEMICAL AND FORMULATION[1]	PRODUCT RATE/ACRE	LBS AI/A	REMARKS AND PRECAUTIONS
Wireworms or Mole Crickets (transplant water treatment)	bifenthrin		0.0625-	Apply in transplant water. Agitate to maintain solution. Apply bifenthrin at these rates as a transplant water treatment instead of a broadcast application.
	(Brigade 2EC)	4-6.4 oz	0.10	
	imidacloprid		0.02 -	
	(Admire 2F & other generic formulations)	1.4 - 2.8 oz./ 1000 plants	0.04 per 1000 plants	
	(Admire PRO 4.6 SC)	0.6-1.2 oz./ 1000 plants		
Wireworms (transplant water treatment)	thiamethoxam		0.01 - 0.02	
	(Platinum 2 SC)	1.3 oz. per	per 1000	
	(T-Moxx 2SC)	1000 plants	plants	

TOBACCO INSECT MANAGEMENT PROGRAM

A tobacco insect management program consists of the periodic monitoring (scouting) of insect populations in fields so that control decisions can be made, based on the kinds and numbers of insects found. All fields should be checked at least once a week from the time tobacco is transplanted until final harvest.

SCOUTING THE FIELD

Insects are not usually distributed uniformly in a field. All parts of the field must be covered each time a field is scouted. The pattern followed as the field is walked is not as important as being sure all parts of the field are covered. A "zig zag" pattern or "X" pattern is most satisfactory in fields where the tobacco plants are small to medium sized. Walking across the rows in fields where the tobacco plants are large is impractical because of the danger of breaking off leaves. A "U" pattern is more practical in such fields.

TAKING SAMPLES

A good sampling method is to carefully inspect 10 consecutive plants at 10 different locations (sample points) in each field. In fields larger than 10 acres, increase the number of sample points proportionately to the acreage in the field. Inspecting more plants will give a more accurate estimate of the insect populations in the field. Samples should not be taken from the outside rows and end plants because these areas are usually more susceptible to insect damage. Insect populations sampled from these areas will appear to be higher than they actually are. Make a practice of entering the field from a different point and direction each time the field is sampled.

INSPECTING PLANTS

Aphids, flea beetles, hornworms and budworms are the major foliage feeding insect pests of tobacco in Georgia. Plants should be examined by checking the buds and upper third of the plant for flea beetles, hornworms and budworms. The undersides of the leaves on the upper to middle part of the plant should be examined for hornworm eggs and aphids. The lower leaves should be examined for honeydew secreted by aphids. When other insects are found, note their numbers and damage.

If an unidentified insect is observed and appears to be causing serious damage to the crop, the insect and samples of its damage should be collected and taken to the County Extension office for assistance in identification and possible control. This is important because beneficial insects are often misidentified as pests. Tobacco fields should be treated when one or more insect pests meet or exceed the treatment thresholds listed below.

Table 3. Treatment Thresholds for Various Insects on Tobacco Based on 100 Plants Sampled.

INSECT	TREATMENT THRESHOLD
Aphids (Plant Lice)	Treat when 10% of the plants have 50 or more aphids on at least one leaf.
Budworms	Treat when 10% of the plants are infested with larvae.
Cutworms	Treat when 5% of the plants are injured or cut off.
Flea Beetles	Treat young plants when 10% of the buds show damage. Treat large plants when leaves begin to look ragged or lacy.
Hornworms	Treat when 10% of the plants are infested with larvae. Do not include worms with parasitic wasp cocoons on their backs in the counts.

MAJOR FOLIAGE FEEDING INSECTS OF TOBACCO

TOBACCO BUDWORMS Tobacco budworms damage tobacco by feeding in the buds, causing ragged or distorted leaves and at times complete destruction of the buds. When the bud is destroyed, early sucker growth occurs. This may cause plant stunting and greater difficulty in controlling suckers. Budworms are particularly hard to kill when they feed inside the bud. To be effective, an insecticide must be concentrated in the buds. The best time to spray an insecticide is early in the morning or during cloudy weather when the buds are open and the larvae are more likely to feed on the leaves. Budworms will also feed and tunnel into stalks and the midribs of leaves. After tobacco is topped, budworms rarely cause economic damage. Tobacco should be treated when 10 percent of the plants are infested with budworms. See Table 4 for recommended insecticides.

HORNWORMS

Both tobacco and tomato hornworms feed on tobacco. The tobacco hornworm is more common in Georgia and is potentially the most destructive insect pest because of its ravenous appetite. Because of its large size and the length of the larval stage, they are capable of completely destroying entire leaves, leaving only the midrib on mature plants. A field should be treated when 10 percent of the plants are infested with hornworms. Until recently, hornworms were easily controlled with low rates of standard insecticides, such as acephate and methomyl. Now it takes the highest labeled rate of these insecticides or the use of carbaryl, spinosad or one of the *Bacillus thuringienis* insecticide to give adequate control. See Table 4.

APHIDS

The tobacco aphid has in recent years become one of the most important pests of tobacco in Georgia. Aphids damage tobacco by sucking plant juices form the undersides of young tobacco leaves. As more and more aphids congregate or are born on the leaves, their waste, called honeydew, drops onto lower leaves. Leaves will become very shiny and sticky. This honeydew, which has a high sugar content, promotes the growth of a fungus called sooty mold. Sooty mold lowers leaf quality because the moldy tobacco will not mature and cure properly. Aphids should be treated when 10 percent of the plants have 50 or more aphids on at least one leaf. There is also evidence that tobacco aphids have become resistant to some of the insecticides growers have used in the past. Good coverage with a recommended insecticide is suggested (Table 4).

FLEA BEETLES

Adult flea beetles damage tobacco by chewing small round holes into or through the leaves, especially from the underside. The larvae feed on the roots of tobacco, leaving entry points for soilborne diseases. After transplanting, they may weaken plants or kill the bud with their feeding. Although damage is more severe on young transplants, it may continue until the crop is harvested. Mature leaves spotted with holes may lessen the quantity of the leaf. Young plants should be treated when 10 percent of the buds show damage. Large plants should be treated when the leaves begin to look ragged or lacy. While both transplant water treatments and foliar sprays give good control of flea beetles on young plants, only foliar sprays are recommended for larger, older plants (Table 4).

TOBACCO SPLITWORM

The tobacco splitworm, also called the potato tuberworm, can cause severe damage to both recently transplanted tobacco and late season tobacco (after it has been topped). The tobacco splitworm feeds and tunnels between the upper and lower surfaces of leaves causing papery, grayish blotches which become brownish and very brittle. On recently transplanted tobacco, they may even tunnel into the bud of the plant. Late in the season injury is usually concentrated on the older, lower leaves. If not controlled, they will progressively move from the lower leaves to the upper leaves of the tobacco plant. No insecticides are labeled specifically for tobacco splitworms. However, methomyl, labeled at the highest rate, has given the best control. Late season control depends upon good coverage of the lower leaves. Use drop nozzles and use enough spray solution to soak the leaves. Using acephate (Orthene 75 S or 97) in the transplant water usually suppresses early season infestations.

Table 4. Control of Foliar Insects on Field Tobacco

INSECT	CHEMICAL AND FORMULATION[1]	PRODUCT RATE/ACRE	LBS A.I.	REMARKS AND PRECAUTIONS
Aphids	acephate		0.5 - 0.75	Good coverage is essential for control. The use of drop nozzles will improve control by depositing insecticides on the underside of the leaves where aphids feed. Apply as broadcast or directed spray to foliage. Apply before pests reach damaging levels. Apply higher rates for heavy infestations. Do not apply bifenthrin later than layby and do not apply more than 0.2 lb a.i./A per season.
	(Orthene 75S)	0.67 - 1.0 lb		
	(Acephate 75 SP)	0.67 - 1.0 lb		
	(Orthene 97 PE)	8-12 oz		
	acetamiprid		0.025-0.75	
	(Assail 80 WP)	0.6-1.7 oz		
	bifenthrin		0.04-0.10	
	(Brigade 2EC)	2.56-6.4 oz		
	imidacloprid		0.025- 0.05	
	(Provado 1.6F & other generic formulations)	2 - 4 ozs		
	methomyl		0.45	
	(Lannate 90SP)	0.5 lb		
	(Lannate 2.4LV)	1.5 pts		
	pymetrozine		0.09	
	(Fulfill 50 WG)	2.75 ozs		
	thiamethoxam		0.03-0.05	
	(Actara 25 WG)	2-3 ozs		
Aphids **(transplant water treatment)**	imidacloprid		0.01 - 0.02 per 1000 plants	Apply in transplant water. Mix thoroughly.
	(Admire 2F & other generic formulations)	1 - 1.4 ozs / 1000 plants		
	(Admire PRO 4.6 SC)	0.6 oz / 1000 plants		
	thiamethoxam		0.01-0.02 per 1000 plants	
	(Platinum 2 SC)	0.8-1.4 ozs / 1000 plants		
	(T-Moxx 2SC)			
	acephate		0.75	
	(Orthene 75S)	1 lb		
	(Acephate 75 SP)	1 lb		
	(Orthene 97 PE)	8-12 ozs	0.5 - 0.73	

Table 4. Control of Foliar Insects on Field Tobacco

INSECT	CHEMICAL AND FORMULATION[1]	PRODUCT RATE/ACRE	LBS A.I.	REMARKS AND PRECAUTIONS
Budworms	acephate		0.75	Use 8-10 gallons of spray per acre, using one hollow cone nozzle per row when tobacco is less than 12-14 inches high. For the remainder of the season, apply 20-40 gallons of spray using 3 hollow cone nozzles per row. Operate equipment at 60 pounds pressure and do not exceed 4 miles per hour.
	(Orthene 75S)	1 lb		
	(Acephate 75SP)	1 lb		
	(Orthene 97PE)	8-12 ozs	0.5 - 0.73	
	bifenthrin		0.04-0.10	
	(Brigade 2EC)	2.56-6.4 oz		
	Chlorantraniliprole		0.065-0.098	
	(Coragen 1.67)	5.0-7.5 oz		
	emanmectin benzoate		0.01 - .015	
	(Denim .16EC)	8 - 12 oz		
	flubendiamide		0.06-0.09	
	(Belt SC)	2-3 oz		
	methomyl		0.45	
	(Lannate 90SP)	0.5 lb		
	(Lannate 2.4LV)	1.5 pts		
	spinosad		0.045 - .089	
	(Tracer 4SC)	1.4 - 2.9 ozs		
	(Blackhawk)	1.6 - 3.2 ozs		
	Bacillus thuringiensis			For best results, apply when worms are very small (less than 1/4 inch long). The material must be eaten by the insect to be effective. Worms will die several days after feeding.
	(Dipel ES)	2 pts		
	(Dipel DF)	0.5-1 lbs		
	(Agree S)	1-2 lbs		
	(Biobit XL)	3 pts		
	(Biobit HP)	1 lb		
	(Condor OF)	1.63 qts		
	(Crymax WG)	0.5-1.5 lbs		
	(Javelin WG)	1 - 1.25 lbs		
	(Lepinox WG)	1-2 lbs		

Table 4. Control of Foliar Insects on Field Tobacco

INSECT	CHEMICAL AND FORMULATION[1]	PRODUCT RATE/ACRE	LBS A.I.	REMARKS AND PRECAUTIONS
Cabbage looper	acephate		0.75	Apply thoroughly. Good lower leaf coverage is essential for control. See remarks under Budworms.
	(Orthene 75S)	1 lb		
	(Acephate 75SP)	1 lb		
	(Orthene 97PE)	12 ozs	0.73	
	emanmectin benzoate		.01 - .015	
	(Denim .16EC)	8 - 12 oz 1 lb		
	Flubendiamide (Belt SC)	2-3 oz	0.06-0.09	
	methomyl		0.45	
	(Lannate 90SP)	0.5 lb		
	(Lannate 2.4LV)	1.5 pts		
	spinosad		0.063-0.089	For best results, apply when worms are small (½ inch long or less). The material must be eaten by the insect to be effective. Worms will die several days after feeding.
	(Tracer 4SC)	2 - 2.9 ozs		
	(Blackhawk)	1.6 - 3.2 oz		
	Bacillus thuringiensis			
	(Dipel ES)	1-2 pt		
	(Dipel DF)	0.5-1 lbs		
	(Agree S)	1-2 lbs		
	(Biobit XL)	3 pts		
	(Biobit HP)	1 lb		
	(Condor OF)	1.67 qts		
	(Crymax WG)	0.5-1.5 lbs		
	(Lepinox) WG)	1-2 lbs		
Cutworms (foliar and transplant water treatments)	acephate		0.75	Apply 25-50 gallons of spray as needed. If acephate was used in the transplant water, a foliar spray may not be needed.
	(Orthene 75S)	1 lb		
	(Acephate 75 SP)	1 lb		
	(Orthene 97 PE)	12 ozs	0.73	
	bifenthrin		.0625-0.10	Apply bifenthrin as a pre-transplant broadcast application incorporated into the top 4" of the soil and not more than 0.2 lbs a.i./A per season. Apply cyfluthrin up to 7 days after transplanting and only 1 application per season.
	(Brigade 2EC)	4-6.4 oz.		

Table 4. Control of Foliar Insects on Field Tobacco

INSECT	CHEMICAL AND FORMULATION[1]	PRODUCT RATE/ACRE	LBS A.I.	REMARKS AND PRECAUTIONS
Flea Beetles	acephate		0.75	Apply in transplant water. Mix thoroughly. Use a minimum of 100 gallons of transplant water per acre.
	(Orthene 75S)	1 lb		
(transplant	(Acephate 75SP)	1 lb	0.75	
water	(Orthene 97PE)	12 ozs	0.73	
treatments)	imidacloprid		0.016 - 0.02	
	(Admire 2F & other	1-1.4 ozs /	per 1000	
	generic formulations)	1000 plants	plants	
	(Admire PRO	0.45-0.6 ozs /		
	4.6 SC)	1000 plants		
	thiamethoxam		0.01 - 0.02	
	(Platinum 2 SC)	0.8-1.3 ozs /	per 1000	
	(T-Moxx 2SC)	1000 plants	plants	
Flea Beetles	acephate		0.5	Use lower rates for small plants. Use higher rates for large plants and thoroughly cover the lower leaves.
	(Orthene 75S)	0.67 lb		
(foliage control)	(Acephate 75SP)	0.67 lb		
	(Orthene 97PE)	8 ozs		
	bifenthrin		0.04-0.10	
	(Brigade 2EC)	2.56-6.4 oz		
	carbaryl		1-2	
	(Sevin 80S)	1.25 - 2.5 lbs		
	(Sevin XLR Plus)	1 - 2 lbs		
	methomyl		0.23-0.45	
	(Lannate 90SP)	0.25 - 0.5 lb		
	(Lannate 2.4LV)	0.75 - 1.5 pts		
	imidacloprid		0.025 - 0.05	
	(Provado 1.6F & other generic formulations)	2 - 4 ozs		
	thiamethoxam		0.03-0.05	
	(Actara 25 WG)	2-3 ozs		
Grass-	acephate		0.25 - 0.5	Apply thoroughly. Spraying around field borders may aid in preventing infestations.
hoppers	(Orthene 75S)	0.33 - 0.67 lb		
	(Acephate 75SP)	0.33 - 0.67 lb	0.25 - 0.5	
	(Orthene 97PE)	4 - 8 ozs	0.2 - 0.5	
	bifenthrin		0.04-0.10	
	(Brigade 2EC)	2.56-6.4 oz		
	carbaryl		0.5 - 1.5	
	(Sevin 80S)	5/8-1 7/8 lbs		
	(Sevin 4F)	0.5 - 1.5 lbs		
	(Sevin XLR Plus)	0.5 - 1.5 qts		

Table 4. Control of Foliar Insects on Field Tobacco

INSECT	CHEMICAL AND FORMULATION[1]	PRODUCT RATE/ACRE	LBS A.I.	REMARKS AND PRECAUTIONS
Hornworms	acephate		0.5	Apply thoroughly. Good coverage
	(Orthene 75S)	0.67 lb		is essential for control. If control
	(Acephate 75SP)	0.67 lb		has been or is poor with either
	(Orthene 97PE)	8 oz	0.5	acephate or methomyl, use
	bifenthrin		0.04-0.10	carbaryl, spinosad or one of the
	(Brigade 2EC)	2.56-6.4 oz		*Bts*.
	carbaryl		1 - 2	
	(Sevin 80S)	1.25 - 2.5 lbs		Do not apply bifenthrin later than
	(Sevin XLR Plus)	1 - 2 lbs		layby and do not apply more than
	Chlorantraniliprole		0.065-0,098	0.2 lb a.i./A per season.
	(Coragen 1.67)	5.0-7.5		
	emanmectin benzoate		.01 - .015	
	(Denim .16EC)	8 - 12 oz 1 lb		
	Flubendiamide		0.06-0.09	
	(Belt SC)	2-3 ozs		
	methomyl		0.23 - 0.45	
	(Lannate 90SP)	0.25 - 0.5 lb		
	(Lannate 2.4LV)	0.75 - 1.5 pts		The material must be eaten by the
	spinosad		.045 - .089	insect to be effective. Worms will
	(Tracer 4SC)	1.4 - 2.9 ozs		die several days after feeding.
	(Blackhawk)	1.6 - 3.2 oz		
	Bacillus thuringiensis			
	(Dipel ES)	0.5-1 pt		
	(Dipel DF)	0.25-0.5 lbs		
	(Agree S)	1-2 lbs		
	(Biobit XL)	0.5-1 pts		
	(Biobit HP)	0.25-0.5 lb		
	(Condor OF)	0.67-1 qt		
	(Crymax WDG)	0.5-1.5 lbs		
	(Javelin WG)	1 - 1.25 lb		
	(Lepinox) WDG)	1-2 lbs		
Mole Crickets	bifenthrin		0.0625-0.10	Apply broadcast to the soil surface
	(Brigade 2EC)	4-6.4 oz		one week before transplanting and
	chlorpyrifos		2 - 3	mix into the top 3-6 inches of soil
	(Lorsban 4E,	2 - 3 qts		immediately. Bifenthrin can also
	Lorsban Advanced)	2 qts	2	be applied at these rates as a
	ethoprop		6 - 12	transplant water treatment instead
	(Mocap 6EC)	1 - 2 gals		of a broadcast application.
Stink Bugs	acephate		0.5 - 0.75	Do not apply bifenthrin later than
	(Orthene 75S)	0.67 - 1.0 lb		layby and do not apply more than
	(Acephate 75SP)	0.67 - 1.0 lb		0.2 lb a.i./A per season.
	(Orthene 97PE)	8-12- ozs	0.5 - 0.73	
	bifenthrin		0.04-0.10	
	(Brigade 2EC)	2.56-6.4 oz		

Table 4. Control of Foliar Insects on Field Tobacco

INSECT	CHEMICAL AND FORMULATION[1]	PRODUCT RATE/ACRE	LBS A.I.	REMARKS AND PRECAUTIONS
Tobacco Splitworm, Tobacco Budworm, Tobacco Hornworm	chlorantraniliprole (Coragen)	5 - 7.5 oz.	0.065-0.98	Apply in transplant water uniformly in the root zone or poor performance may occur. Do not apply more than 15.4 fl oz CORAGEN® or 0.2 lbs. a.i. of chlorantraniliprole containing products per acre per crop season.
Thrips	Foliar treatments for flea beetles give helpful control			
Wireworms (soil incorporated)	bifenthrin (Brigade 2EC)	4-6.4 oz	0.0625-0.10	Apply broadcast to the soil surface one week before transplanting and mix into the top 3-6 inches of soil immediately. Bifenthrin can also be applied at these rates as a transplant water treatment instead of a broadcast application.
	chlorpyrifos (Lorsban 15G)	13.5-20 lb	2 - 3	
	(Lorsban 4E)	2 - 3 qts		
	(Lorsban Advanced)	2 qts		
	ethoprop (Mocap 6EC)	1 - 2 gals	6 - 12	
Wireworms or Mole Crickets **(transplant water treatment)**	bifenthrin (Brigade 2EC)	4-6.4 ozs	0.0625-0.10	Apply in transplant water. Mix thoroughly. Use a mimimum of 100 gallons of transplant water per acre.
	imidacloprid (Admire 2F & other generic formulations)	1.4 - 2.8 oz./ 1000 plants	0.02 - 0.04 per 1000 plants	
	(Admire PRO 4.6 SC) **(transplant water treatment)**	0.6-1.2 ozs / 1000 plants		
Wireworms only **(transplant water treatment)**	thiamethoxam (Platinum 2 SC) (T-Moxx 2SC)) **(transplant water treatment)**	1.3 oz. per 1000 plants	0.02 per 1000 plants	

Precautions

Workers should wear protective clothing when they handle treated tobacco. Schedules for insecticides with restrictions on field reentry and tobacco harvest as well as the chemical insecticide group are listed in the table below:

INSECTICIDE	HOURS BEFORE FIELD REENTRY	INSECTICIDE GROUP	DAYS FROM LAST APPLICATION TO HARVEST
acephate (Orthene/Acephate)	24	1B	3
acetamiprid (Assail)	12	4	7
Bacillus thuringiensis (Dipel, Agree, Biobit, Condor, Crymax, Javelin, Lepinox)	4	11	0
bifenthrin (Brigade)	12	3A	Last application by layby
carbaryl (Sevin)	12	1A	0
chlorantraniliprole (Coragen)	4	28	1
emamectin benzoate (Denim)	48	NA	14
Flubendiamide (Belt)	12	28	14
imidacloprid (Admire, Admire Pro/Provado)	12	4A	14
Lambda-cyhalothrin (Warrior)	24	3	40
methomyl (Lannate)	48	1A	5
pymetrozine (Fulfill 50 WG)	12	9B	14
Spinosad (Tracer 4SC)	4	5	3
thiamethoxam (Actara/Platinum, T-Moxx 2SC)	12	4	14

NA = Not Applicable

PREMATURE FLOWERING MANAGEMENT

J. Michael Moore

The cause of early flowering is not completely understood, but thought to be associated with variety genetics, the environmental conditions in which the tobacco was grown and when it was transplanted. This condition is more likely to occur with sensitive varieties such as NC 82, NC 2326, and Coker 371-Gold during seasons of unseasonably cool, overcast weather while the plants are still in the beds and/or when cool, wet field conditions occur shortly after transplanting. In addition to environmental conditions, early flowering is also thought to be triggered by other forms of stress. This stress may be drought, excessive soil moisture, nitrogen deficiency, root damage, fertilizer injury or chemical injury.

Tobacco crops can generally tolerate an accumulation of approximately 10% stand loss without serious yield losses. If losses to other pests or diseases are high the level of premature flowering which might be tolerated would be lower.

A distinction between excessively premature flowering of plants which have not and will not produce harvestable leaves and those which flower slightly earlier than the majority of plants in the field but with near normal numbers of harvestable leaves should be made. In the first case, plants should be cut back to leave one to two leaves. Suckers will begin to grow from the remaining leaf axils. After allowing the suckers to reach two to three inches in length, remove extra suckers leaving only the best sucker in the second leaf axil from the top. In the latter case, plants which may have produced some harvestable leaves, but flowered early may be topped a little lower than normal and cleaned up to leave the second or third sucker from the top after allowing the suckers to grow to two to three inches in length. In both cases, additional leaves may be added before the bud is removed by the first or second contact sucker control application.

Chemical sucker control applications should **not** be delayed because of remedial actions taken to increase the leaf counts of a few premature flowering plants. In fact, early hand application of a contact type fatty alcohol or Prime^{+} may be used to control the growth of additional suckers below the one left. In some cases, growers should take the appearance of a few slightly early flowers as a signal to get prepared to start their sucker control programs.

Plowing up the crop and starting over should be the last option considered in most cases. Replanting adds to production costs and increases the chances for lower than normal yields. Topping and turning out a sucker is usually the most practical option. Growers should be aware of the threat of spreading mosaic during this operation and follow good sanitation practices. Workers should avoid touching plants which show symptoms of mosaic and should wash their hands and knives frequently in a milk solution or in a strong phosphate containing soap to remove and deactivate the virus.

TOPPING AND CHEMICAL SUCKER CONTROL PROGRAMS FOR GEORGIA

J. Michael Moore

PRODUCTION OF TOPS AND SUCKERS

Tobacco produces a single stalk with a terminal or apical bud at the top. The terminal bud exhibits apical dominance. At each leaf axil lateral buds may be produced if the terminal bud is lost, removed or allowed to go completely to the production of flowers. These lateral buds are called "suckers" and grow especially fast after the removal of the terminal bud and the loss of apical dominance.

After apical dominance is lost suckers in the top three or four leaf axils begin to grow. There is a potential for the production of three suckers in each leaf axil. As long as the primary sucker is allowed to grow the others generally do not begin to grow. If the growth of the primary sucker is controlled or the sucker removed, the next sucker in the leaf axil will begin to grow. The goal of chemical sucker control should be to control as many of the suckers as possible in each leaf axil before the sucker begins to grow.

BENEFITS OF TOPPING AND SUCKER CONTROL

Removal of the tops along with the removal or restriction of sucker growth results in certain desirable changes in the cured leaf. Benefits of topping and sucker control include; increased root growth, reduced weight in the top of the plant, a reduction of the translocation of nutrients and moisture from lower leaves to support the growth and development of upper leaves. Increased root growth means an increase in the potential for uptake of water and nutrients, increased support for the upper plant against wind, and an increase in the plant's potential to synthesize nicotine. Topping can remove significant weight and wind foil from the top of the plant and prevent the plant from being blown over during wind gusts or rain storms. As long as the terminal bud remains in place the plant will rob from lower leaves to support the development of flowers and production of seeds. Once apical dominance is broken, there is more support for the upper leaves and less drain on the lower leaves.

TOPPING

Topping, and the time of topping, can have a significant effect on the physical and chemical nature of cured leaf. Topping improves yield, increases price and value per acre, and increases the alkaloid and sugar content of cured leaf. Topping in combination with removal of suckers can increase yield, alkaloids and sugars more significantly than topping alone when compared to the not-topped plant. To obtain maximum yield and financial returns tobacco must be topped and the suckers controlled. Topping and sucker control may be by removal, either by hand or machine, or by the use of plant growth regulator chemicals.

TOPPING HEIGHT

Most tobacco varieties will produce a maximum of yield and quality when the top is removed after the production of 18 to 22 leaves. Any excess foliage or floral growth beyond this point is removed and thrown on the ground and is of no benefit to the plant or financially to the grower. The goal should be to remove as little from the top of the plant as possible as soon as possible and to minimize the production of suckers which also take away from maximum yield production and require hand labor to remove them. Topping at lower leaf numbers reduces leaf area per plant and increases the concentration of nicotine.

TOPPING TIME AND YIELD

As the tobacco plant changes from the vegetative state to the reproductive state the bud under goes a developmental change from production of leaves and becomes a flower. This transformation takes approximately 21 days from the "button stage" when the bud is visible in the center of the plant as a "button" or "ball" of unopened florets until the "late flower stage" when all of the florets in the top have flowered and some are shedding. Following the button

stage, approximately seven days later, and the next stage of development is the "early flower stage" when only a few florets are beginning to open and show the white color of the flowers. Seven days later is the "full flower stage". During this progression the plant continually channels water and nutrients to the terminal bud to insure production of flowers and the eventual reproduction of the species as seeds. As the tobacco plant is allowed to progress from one stage to the next the top continues to rob the plant and the producer of yield and quality.

Yield and price/cwt is lowered when topping is delayed beyond the early flower stage. Total alkaloid content is reduced as topping time is delayed, except from the full to late flowering stage, and sugar content is lowered with delayed topping after the early flower stage. Total nitrogen content is not materially affected by topping time. The number and weight of suckers are reduced by delays in topping. Leaves from plants topped earlier will be thicker, and have more oil and body, especially those in the upper part of the plant.

When topping is combined with chemical sucker control rater than hand removal of suckers yield is improved. Topping in the button stage with chemical sucker control rather than topping in the early flower stage increases yield. A number of other benefits of topping at the button stage make this the ideal time to perform this task. In most instances topping at the button stage will occur prior to beginning harvest. This allows for better utilization of labor and reduces the need to be performing the two tasks at the same time. When the top is not allowed to develop beyond the button stage the threat of top heavy plants being blown over by windstorms is considerably reduced. Early topping will stimulate further root growth and will further anchor the plant against wind as well as improve the plant's ability to survive dry soil conditions. Early topping also serves to remove some of the attraction to the plant of numerous insect pests which spread a number of virus diseases such as tomato spotted wilt virus as well as those which lay eggs that hatch into feeding insects. Reducing insect populations can reduce insecticide costs, residues and hazards to laborers as well as reducing potential disease losses.

CHEMICAL TOPPING

Although tobacco plants are typically topped either by hand or mechanically, topping may be accomplished chemically before the emergence of the button and opening of any flowers. Chemical topping would appear to be the ideal method for eliminating the production of excess leaves and the top which will flower. The presence of a percentage of plants which are chemically topped by the application of contact fatty alcohol materials is an indication that the application occurred on a timely basis and the solution concentration was strong enough to kill suckers. With strong solution concentrations a higher percentage of suckers are killed in leaf axils contacted by the solution. Chemical topping of plants in the prebutton stage eliminates the production of excess leaves and tops which are discarded and do not add to yield of cured leaf. Plant resources can now be concentrated to produce fewer, larger, thicker and heavier leaves. Leaf body can be increased by early chemical topping and redirection of these plant resources.

TOPPING PLANTS UNDER STRESS

Tobacco should be topped early during periods of drought to maximize leaf production from already short soil and plant moisture supplies as well as to stimulate further root growth and greater moisture update potential.

Tobacco should also be topped early under conditions of excess soil moisture. Again, the plants will benefit from the root growth which is stimulated by removal of the top. Sometimes this additional root growth will be needed to to replace roots which have rotted and have reduced the moisture uptake to support the upper plant to 40 percent of normal. This reduction in water uptake when the plant is also under stress from extreme heat can lead to wilting and collapse of the leaves. Prolonged wilting can result in loss of leaves or portions of leaves.

Tobacco which has been over fertilized with excess nitrogen has a tendency to produce a thin leaf. Topping excessively fertilized plants at a higher leaf number can lead to a greater number of thin leaves. Normal topping height may be effective in causing these thin leaves to thicken up with time. However, the high availability of nitrogen will drive the production of suckers and sucker growth. An aggressive sucker control program is required.

CHEMICAL SUCKER CONTROL

Three types of sucker control chemicals are available for use by tobacco growers in the U.S. They are **Contacts, Systemics, and Contact-localized-systemics**. A knowledge of how the various sucker control chemicals work is important to obtaining optimum control. Once how the chemicals work is understood, the stage of plant development for optimum sucker control with each chemical must also be kept in mind.

Contacts are fatty alcohols (C_{10} or a mixture of C_6-C_{12} alcohols) and act by giving contact kill of suckers smaller than 1 to 1.5 inches in length. First, the waxy coating which retains water in the tender growth of the sucker is broken down by the contact. Then, in the full sunlight the sucker gives off more water than the plant can replace causing the sucker to turn brown, dry up and die. Sucker growth that is too large may not be killed because of a thicker waxy protective coating.

Multiple applications of contact fatty alcohols are normally used to kill young suckers up to one and one half inches long which develop in the top of the plant as the button emerges and the flower develops. Applications usually are made on a five to seven day schedule at increasing solution concentrations to follow the growth of new suckers as new leaves emerge. As the tissues in the bud grow older, the waxy coating on them increase and less damage is caused by greater concentration of fatty alcohols. Multiple applications also allow time for plants in the same field to have reached the same stage of development and for the upper leaves to develop to a sufficient size which will not be damaged by future applications of other sucker control chemicals which inhibit cell division.

The concentration of the contact solution is of primary importance in obtaining sucker control. It is important that contacts are mixed in the proper proportions before spraying onto the field. The contact sucker control materials containing fatty alcohol are the only chemicals that must be mixed with water in the proper proportions to be effective. Solution concentrations used typically range from three to five percent. The effectiveness of sucker control will be reduced if the concentration of the contact solution is too weak. Weak contact solutions may cause superficial damage to suckers in the short term and result in poor, late-season sucker control. Although the effectiveness of sucker control by contact solutions is considerably improved by increasing concentration, if the concentration is too great, the solution may cause leaves to be burned and excessive injury to leaf axils. Excessively burned leaf axils may serve as entry sites for certain disease organisms and may be weakened resulting in the loss of heavy leaves.

At least three suckers may grow from the area in which the leaf and the stalk join. It IS possible to control suckers that have not developed to the point that they may be seen. However, this again calls for proper concentration of contact material. In other words, the solution must be hot enough to burn beyond the sucker you can see and to dry up the tiny suckers which have not yet developed to the point you can see them.

In uniformly growing tobacco, the first application of a contact sucker control chemical should be made when 40 to 50 percent of the plants in the field have reached the early button stage. This initial application of contact fatty alcohol will burn out small suckers that are beginning to grow and will allow the field to become more uniform as additional plants come into button and full flower stages of development. At least five to ten percent of the plants should have their buds burned out by the initial application of contact. If some buds are not burned out the application was applied later than optimal or was not mixed at a high enough concentration.

The first application of contact should contain at least one and one half gallons of contact for each 48.5 gallons of water (3% solution) to be effective. Later applications should contain two to two and one half gallons of contact per 48 to 47.5 gallons of water (4% to 5% solutions). At least two and possibly three applications of contact applied on a five to seven day schedule may be required to keep sucker growth from becoming a problem.

Other factors also affect the burning appearance of contact solutions. Tender sucker tissues may be burned by weaker contact fatty alcohol solutions. Older, larger, sucker growth may require the use to stronger solutions. Bright, sunny conditions when temperatures are high promote better effectiveness of contacts. The concentration

of contact fatty alcohol used may need to vary based on the time of day, degree of cloudiness, temperature and previous soil moisture status under which sucker growth has been produced.

Tops containing at least one flower should be removed after each application of contact chemical. Allowing tops, suckers and flowers to remain on the tobacco plants until the full field is in full flower has been determined to result in the loss of 27 pounds per acre per day of saleable tobacco.

Contacts should be applied at relatively low pressure, (20 to 25 psi) with nozzles which deliver large droplets (solid cone type) in sufficient volume (50 gallons per acre) to cause the solution to run down the leaf midribs to the stalk and wet each leaf axil all the way to the soil surface. Hand application of contacts with a single nozzle or poured from a jug is also possible and may be necessary for small operations or under circumstances where plants in the same field are not uniform. Plants must be uniformly standing in an upright position to allow the solution to run around the stalk to leaf axils on all sides. Contact solutions should be continuously agitated to insure that the lighter than water alcohols stay mixed in solution.

Systemics enter the plant and travel throughout the plant stopping cell division and therefore stopping the growth of young, tender, rapidly growing, tissue such as suckers. Maleic hydrazide (MH) is the systemic used. MH is taken up most readily by the youngest most rapidly growing portion of the plant, generally the top one third of the plant, and gives long-term control of sucker growth. MH is most effective when applied to a plant which has been actively growing under good moisture conditions. Absorption is also better when temperatures are not too extreme and stomata are not closed such as in the mornings after the dew has dried.

After MH application, large suckers that are already present develop much slower and with very narrow leaves. Upper plant leaves which are at least 10 to 12 inches long develop to their normal size because of continued cell elongation even though cell division has stopped. Further development of existing suckers occurs at a reduced rate.

Under normal growing conditions MH will control the growth of new suckers for only about six weeks after application. Since the time between topping and the final harvest is usually greater than six weeks, scheduling of the MH application is important. Timing and the number of applications of contacts can be used to delay the time of MH application beyond the first harvest, thus shifting the window of control to cover a later part of the season.

Currently produced varieties have better root systems, are more disease resistant, respond to higher fertilization and mature later than older varieties and may remain in the field for longer periods of time. Control can be further improved and longevity of control extended beyond that normally expected of MH alone by including a contact-localized-systemic such as flumetralin in the sucker control program. The contact-localized-systemic can be applied either in a separate application before or after MH, or as a tank mix with MH.

When MH is applied alone, the goal of the application procedure should be to wet the upper surfaces of the leaves in the top one third of the plant. Application pressure should be 25 to 30 psi and 30 to 35 gallons per acre of spray solution should be directed toward the top of the plant with nozzles which deliver medium sized droplets (small solid cones). Care should be taken not the apply the solution to the lower stalk positions which will be harvested soon. MH alone should not be expected to control sucker growth for an entire growing season and should always be supplemented with multiple applications of contacts and/or an application of flumetralin for a full season control program.

MH residues are greater in tobacco than are the residues for any other pesticide used on tobacco. These relatively higher residues are of concern to manufacturers because of the requirements of some countries for final manufactured products with limited MH residue levels. These restrictions appear to be based on the relatively high residue numbers for MH in tobacco rather than on real and specific justifications. MH has recently been reregistered by the Environmental Protection Agency and has been shown not to be a cause of health problems. Average MH residues have been reduced significantly in U.S. produced tobacco in the last seven years by growers who have begun to utilize alternative chemical sucker control programs which do not place primary sucker control emphasis on MH alone. MH use rates have been reduced and sucker control has actually improved with the

incorporation of timely applications of contacts and contact-localized-systemics in the sucker control programs. In addition, changes in MH application procedure and timing have changed to take advantage of naturally occurring conditions which can help to reduce residues. Application of MH following the first harvest means that the MH residues in the first harvest are zero. By waiting to harvest after MH application until rainfall or irrigation has occurred can also be effective in reducing residues by as much as half.

Tankmixes of contact and MH may be applied in place of the normal MH to provide additional burnout of small suckers which may not be adequately controlled by MH alone. At least two premixes of these materials are available, but the individual materials may be mixed in the tank to provide the desired MH and contact solution. A four to five percent contact solution is recommended. Application procedure should be that described for application of contact solution. The top leaves will receive adequate MH from the solution which covers them.

Contact-localized-systemics such as flumetralin (Drexelin Plus, Prime+, or Flupro) or butralin (Butralin) must be applied directly to the leaf axil where suckers grow and works systemically in the local leaf axil by stopping cell division and preventing sucker growth. Contact-localized-systemics do not move readily throughout the plant. For this reason contact-localized-systemics must be applied to wet each leaf axil as any leaf axils that are missed will grow large suckers which must be removed by hand. Contact-localized-systemics do not cause suckers to turn brown and dry up, but causes small suckers to turn to a pale green and become constricted with minimal further growth.

Access to these three types of chemical materials has lead to the development of a number of sucker control programs which utilize the advantages of each type of material by application at specific times in the development of the plant and the sucker. All programs depend on uniform application of only the needed nitrogen fertilizer which should allow normal ripening of the crop without delaying maturity or unnecessarily promoting sucker grow. Applications containing mixes of two or more of these chemical types may be useful in obtaining maximum sucker control.

TOPPING AND CHEMICAL SUCKER CONTROL PROGRAMS

Good sucker control increases yield and quality, helps reduce foreign matter in harvested tobacco, improves the efficiency of harvesting and handling, and may improve the grade and price of tobacco at auction. In order to effectively control suckers the crop must not be over-fertilized and the application of sucker control chemicals must start early (when 30 to 40 percent of the plants are in the early button stage) and be continued on a timely basis (5 to 7 days between contacts and 5 to 7 days between contacts and MH or a contact localized systemic.

The following topping and chemical sucker control programs have been used successfully by tobacco growers. Their effectiveness depends on timely treatment and application of the correct rate of nitrogen with non-excessive adjustments for leaching. Excessive nitrogen applications often result in sucker growth which is uncontrollable with any of the chemicals available.

PROGRAM I

STEP 1. Apply the first of at least two contact sucker control (Off Shoot T, Contact-85, Sucker Plucker, Fair 85, etc.) treatments when 30 to 40% of the plants are in the early button stage. Three applications of contact can further delay the application of MH, allowing harvest prior to MH application.

- Timeliness of this first application is one of the keys to effective sucker control. Start early enough to insure that 5 to 10% of the plants are chemically topped (the bud is burned out).

- Concentration is another key. A 3% concentration of contact (1.5 gallons of contact in 48.5 gallons of water) should be applied in approximately 50 gallons of solution per acre. A second application of contact should be applied at a 4% concentration (2 gallons of contact in 48 gallons of water) in approximately 50 gallons of solution per acre 5 to 7 days following the last application. The solution should be applied in sufficient quantity to run down the stalk even if additional solution is required. Do not expect suckers longer than one inch to be chemically removed.

STEP 2. Top flowering plants as soon as the contact solution has dried on the plants after each application.

STEP 3. Make a third application of contact 5-7 days following the initial treatment to remove suckers that have grown out since the first application. A 5 % concentration may be used for the third application (2.5 gallons of contact in 47.5 gallons of water).

STEP 4. Top all remaining plants following the final contact application.

STEP 5.

OPTION A - Apply maleic hydrazide (MH) about 5 to 7 days after the final application of contact. The labelled rate for MH is 2.25 lbs ai/A (1.5 gal/acre of the products containing 1.5 pounds of active ingredient and 1.0 gal/acre of product containing 2.25 lb of active ingredient).

- Use a three nozzle arrangement (TG-3, TG-3, TG-3) and sufficient pressure (20 to 35 psi) to cover the upper one third of the plant - the fastest growing part of the plant and the part which will most readily take in the MH. Apply 30 to 35 gallons of solution per acre. A second application is permitted only if rainfall results in the washoff of the original application. Less than the full rate may be needed when substantial rain occurs within 4 hours after the first application (1.13 lbs ai/A; 3 quarts of the 1.5 lb/gal. or 2 qts. of the 2.25 lb/gal. material). Re-application is not required if rain occurs 10 to 12 hours after application. IN ORDER TO MINIMIZE MH RESIDUES DO NOT harvest until 7 days after application or until a 0.25 inch rainfall or irrigation occurs.

STEP 5.

OPTION B. - Apply a tankmix of 2.25 lbs/A of MH and 2 qts/A of flumetralin at the normal time for MH application and 5 to 7 days after the last contact application. Application should be made as a coarse spray in 50 gallons/acre of total solution as with contact applications (TG-3, TG-5, TG-3).

STEP 5.

OPTION C. - Apply a tank mix of contact and MH about 5-7 days after the second contact at the rate of 4 percent contact and 2.25 lbs MH/Acre. IN ORDER TO MINIMIZE MH RESIDUES, DO NOT harvest until 7 days after application or until rainfall occurs. There are two premix products which are combinations of a contact alcohol and MH and sold for this treatment, but contain 11% less MH than other MH products, based on labeled rates. To insure full season sucker control, add 2 qts. of flumetralin to the tankmix, or apply 2 quarts of flumetralin in a separate application after the last contact and before the MH/Contact tankmix.

PROGRAM II

OPTION A. FLUMETRALIN (DREXALIN PLUS, FLUPRO, OR PRIME+) - DROPLINE OR JUG METHOD

- Top and hand sucker the tobacco beginning when approximately 50% of the plants are in the elongated button to early flower stage.

- Apply flumetralin with either the drop-line or jug method using 1/3 to 2/3 fl. oz. of solution per plant (only enough to reach the bottom of the stalk) during the topping process or immediately thereafter. Prepare the solution by mixing 2.5 fl oz Prime+ OR 1.5 to 1.75 fl oz flumetralin per gal. of water).

- Top and hand sucker the remainder of the plants as they reach the appropriate stage and treat with the same solution of flumetralin. Plants previously treated should not be treated a second time.

OPTION B. (*MH FREE*) CONTACT / CONTACT / CONTACT / Contact-Localized-Systemic / CONTACT-CONTACT-CONTACT

- Apply multiple applications of contacts of increasing concentrations (3% / 4% / 5%) beginning when not more than 30 to 40% of the plants are in the early button stage and continuing on a 5 to 7 day schedule to control early suckers as they emerge and allow the upper plant leaves to more fully develop. Top plants that have flowered after each application.

- Apply 30 to 50 gallons of a solution prepared by mixing 2 quarts of flumetralin OR 3 qts of flumetralin in 50 gallons of water per acre with droplines, jugs, or a power sprayer 3 to 5 days following the last contact application. Accuracy of control is improved with hand application using droplines or jugs, but increases the labor requirements. Apply as a contact to run down the stalk. Stalks must be standing straight for the most efficient control.

- An additional application of no more than 1 quart of flumetralin applied with a mechanical sprayer may improve long term control by treating untreated leaf axils when applied 5 to 7 days after the initial fluemetralin.application. Additional applications of 5% contact solutions may be required on a 5 to 7 day schedule to provide additional control of missed suckers. Additional hand sucker removal may be required to prevent suckers from becoming unwanted foreign material in the harvested leaf.

OPTION C. CONTACT / Contact-Localized-Systemic / MH

- Apply one or more applications of a contact at 4% concentration beginning when not more than 30 to 40% of the plants are in the early button stage.

- Apply 30 to 50 gallons of a solution prepared by mixing 2 quarts of flumetralin OR 3 qts of flumetralin in 50 gallons of water per acre with droplines, jugs, or a power sprayer 3 to 5 days following the last contact application. Apply as a contact to run down the stalk.

- Apply 2.25 to 3 lbs a.i. of MH to cover the top of the plant 5 to 7 days after applying a Contact-localized-systemic. IN ORDER TO MINIMIZE MH RESIDUES, DO NOT REAPPLY MH. DO NOT HARVEST FOR 7 DAYS OR UNTIL AFTER RAINFALL OR IRRIGATION.

MINIMIZE MH RESIDUES

Some tobacco purchasers have established limits for MH in either their finished cigarettes or tobacco before manufacturing. Because of the global nature of the tobacco industry, all buying companies are being forced to monitor the MH residues of tobacco they purchase. MH residues can be related directly to use rate, re-application, application method, and time and rainfall occurring between application of MH and harvest. While it is not yet feasible to determine the residue level of an individual grower's tobacco prior to auction, each pile can be traced back to the producer. Buying companies are aware of the MH residues associated with individual markets and may leave a market known to have higher than acceptable levels. Growers are encouraged to follow the label instructions for applying all pesticides for the good of the entire industry.

FOLLOWING ARE A FEW POINTS TO AID IN MINIMIZING MH RESIDUE.

1) **Do not over-fertilize.**

2) **Use multiple applications of contacts to reduce the dependence on MH.**

3) **Use labeled application rates of MH.**

4) **Apply MH to upper side of upper one third of the leaves on the plants.**

5) **Apply MH in a single application. Do not use split applications.**

6) **With wash-off of MH in less than 4 hours, reapply only one half the rate.**

7) **Apply MH when tobacco is turgid; not in a drought condition.**

8) **Wait 7 days or until after rainfall or irrigation occurs between MH application and harvest.**

9) **Irrigate with 1/4 to 1/3 inch prior to harvest if rainfall does not occur within 7 days.**

10) **Incorporate Contact-Localized-Systemics into sucker control programs.**

Mean maleic hydrazide (MH) residues (ppm) for flue-cured tobacco by belt and year.

TYPE	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
14 (GA/FL)	192	178	196	200	118	139	128	119	120	130	194	95	138	125	130	210	173
13(SC)	136	159	211	183	143	131	124	94	96	140	164	91	100	76	135	127	125
13(NC)	103	127	163	210	137	148	128	120	90	140	194	98	66	72			
12(NC)	146	144	168	138	135	141	117	114	89	153	140	95	80	109	115	103	117
11-B(NC)	73	110	109	103	124	104	112	114	75	93	118	53	64	74	101	128	81
11-A(NC)	69	66	85	74	42	45	37	80	58	44	33	36	31	54	69	73	37
11-A(VA)	62	34	28	76	38	48	34	39	41	41	42	27	39	39	39	26	38
AVG	**143**	**124**	**147**	**140**	**115**	**117**	**103**	**101**	**85**	**120**	**132**	**78**	**80**	**86**	**100**	**111**	**91**

MH residue samples are not taken by third parties since the Tobacco Buyout Legislation, the end of the auction process and the beginning of contract delivery of tobacco to buying company operated receiving stations.

REGIONAL CHEMICAL SUCKER CONTROL TEST

S. S. LaHue - UGA
C. E. Troxell - UGA
J. M. Moore - UGA

Introduction

Chemical growth regulators are extensively used by tobacco growers in Georgia to control sucker growth. These materials are an essential component of the production process because they increase yield and reduce labor costs. The need for more effective materials and methods continues because of the necessity of reducing residues, specifically maleic hydrazide (MH). Some foreign markets require maleic hydrazide residues of 80 ppm or less. Since exports are a major outlet for the Georgia crop, MH residues above 100 ppm must be reduced.

The tobacco season has lengthened because currently used cultivars benefit from irrigation and higher nitrogen rates. Moreover, the incidence of Tomato spotted wilt virus (TSWV) has increased in Georgia causing additional sucker pressure and difficulty in control due to variability in stands and flowering. The use of dinitroanalines (DNA) in combination with maleic hydrazide have shown success in controlling suckers over the lengthened season while a third or even fourth contact has dealt with the variable stand due to TSWV. These problems can be managed while reducing MH residues.

The purpose of this year's study is to report the effectiveness of some new combinations of existing materials used in combination (sequential) with fatty alcohols (a contact) and the potassium salt of maleic hydrazide (a systemic) with and without the added benefit of dinitroanalines. In addition, spray hoods (conveyors) were evaluated for the possibility of reducing residues while enhancing control. These treatments are compared with topped but not suckered and the standard treatment (for 2012) of three contacts followed by the recommended rate of maleic hydrazide in a tank mix with one of the dinitroanalines. Each treatment is analyzed with respect to agronomic characteristics and chemical properties of the cured leaf.

Materials and Methods

The field experiment was conducted at the University of Georgia Tifton Campus Bowen Farm. All cultural practices, harvesting, and curing procedures were uniformly applied and followed current University of Georgia recommendations. Fertilization consisted of 6 lb/A of 9-45-15 in the transplant water, 500 lbs/acre of 6-6-18 at first cultivation, 600 lbs/acre of 6-6-18 at second cultivation, and an additional 120 lbs/acre of 15.5-0-0 at lay-by for a total of 85.7 lbs/acre of nitrogen. Plots consisted of two rows of thirty plants each. Ten uniform plants were sampled from each plot for sucker data. Residue samples were pulled from cured yield samples and ground through a 2mm screen. The test involved four replications randomized with fourteen sucker control treatments as follows:

1. TNS - Topped Not Suckered.

2. Fair 85/Fair 85/ Fair 85 /(Fair 30 + Prime +) - Three treatments of the contact Fair

85 (Fair Products, Inc.) at 4% solution followed in 3 days with two applications of a 5% solution three to five days apart. Five to seven days later a tank mix of Fair 30 (2.25lbai/gal)(Fair Products, Inc.) potassium maleic hydrazide at the labeled rate of 1.0 gal/A and /Prime + (Syngenta Corporation) at 0.5 gal/A. Each application utilized a standard three nozzle configuration (TG3-TG5-TG3) applying 52 gal/A at 20 psi.

3. Fair 85/Fair 85/Fair 85/Prime +/ Fair 30 - Three treatments of contact as in treatment 2 followed in 5 days with Prime + at 0.5gal /A followed by Fair 30 at 1.0 gal/A after the first harvest. All applications were applied as in treatment 2 except sprayer hoods (Agri-Supply #78424) were installed for the last two applications.

4. Fair 85/Fair 85/ Fair 85/Prime +/ Fair 30 - The same combination and timing of applications as in treatment 3 without the sprayer hoods.

5. Fair 85/Fair 85/ Fair 85/Prime +/ Fair 30 - Three treatments of contact as in previous treatments followed in 5 days with Prime + at 0.5gal /A followed by Fair 30 at 0.66 gal/A. All applications were applied and timed as in treatment 3 including the sprayer hoods.

6. Fair 85/Fair 85/ Fair 85/Prime +/ Fair 30 – The same combination and timing of applications as in treatment 5 without the sprayer hoods.

7. Fair 85/Fair 85/ Fair 85/Prime +/ Fair 30 - Three treatments of contact as in previous treatments followed in 5 days with Prime + at 0.5gal /A followed by Fair 30 at 0.33 gal/A. All applications were applied and timed as in treatment 3 including the sprayer hoods.

8. Fair 85/Fair 85/ Fair 85/Prime +/ Fair 30 – The same combination and timing of applications as in treatment 7 without the sprayer hoods.

9. Fair 85/Fair 85/ Fair 85/(Fair 30 + Prime +)/Prime + - Three treatments of contact as in previous treatments followed in 5 days with a tank mix of Fair 30(0.33gal/A) and Prime + (0.5gal /A) followed by Prime + at 0.25 gal/A after the first harvest. All applications were applied as in treatment 2 except sprayer hoods were installed for the last two applications.

10. Fair 85/Fair 85/ Fair 85/ (Fair 30 + Prime +)/Prime + - The same combination and timing of applications as in treatment 9 without the sprayer hoods.

11. Fair 85/Fair 85/ Fair 85/ Prime +/ Prime + - Three treatments of contact as in previous treatments followed in 5 days with Prime + at 0.5 gal/A followed by Prime + at 0.25 gal/A after the first harvest. All applications were applied as in treatment 2 except sprayer hoods were installed for the last two applications.

12. Fair 85/Fair 85/ Fair 85/ Prime +/ Prime + - The same combination and timing of applications as in treatment 11 without the sprayer hoods.

13. Fair 85/Fair 85/ Fair 85/ Prime +/ Butralin - Three treatments of contact as in previous treatments followed in 5 days with Prime + at 0.5 gal/A followed by Butralin (Chemtura) at 0.25 gal/A after the first harvest. All applications were applied as in

treatment 2 except sprayer hoods were installed for the last two applications.

14. Fair 85/Fair 85/ Fair 85/ Prime +/ Butralin - The same combination and timing of applications as in treatment 13 without the sprayer hoods.

Results and Discussion

Due to historically high TSWV incidence at the Bowen Farm location, c.v. K 326 was treated in the greenhouse with labeled rates of Actigard and Admire for TSWV suppression and transplanted on March 22. Favorable conditions followed transplanting aiding initial growth. TSWV counts indicated an infection rate below 4% in the test. Generally, the crop was free of disease with a near perfect plant stand.

The first contact was applied on May 30, the second on June 3, and a third set of contacts applied on June 7. All contacts were applied with a standard 3 nozzle arrangement. The fourth application was applied on June 13. The final application for treatments 3 through 14 was applied on June 20. The final harvest was on July 31, with the test concluding after the suckers were pulled, counted, and weighed off 10 plants from each plot on August 1.

The 2012 growing season was notable for its early spring and near normal weather conditions. However, inconsistent rains required 9 irrigations which delivered approximately 8 inches of water on top of 11.6 inches of rain which fell during the 19 week test period.

For 2012, yield and quality data varied little between treatments with the exception of treatment 1(TNS). Test yields were average with the TNS having the lowest yield at 2142lb/A. Treatment 12 yielded the highest at 3054lb/A and had the highest value bringing in $5498/A. The standard treatment 2 brought in $5073/A as compared to the lowest of $3688/A for treatment 1. The price and grade indices were consistent and average for all treatments.

Sucker control was excellent with sucker number per plant low with a mean value of 1 or less for all chemical treatments. Green weight per plant was higher and percent control was lower for treatments which used contact only. Finally, percent control was excellent (>98%) for all chemical treatments with MH. Treatments which incorporated contacts in combination with DNA's also provided good control. As a result, increasing the spray applications and lowering MH rates can provide adequate control and should reduce MH residues. Generally, the spray hoods did not seem to provide additional control over the standard nozzle configuration. MH residue samples should provide greater insight into the success of reducing residue levels for treatments 2-10. Unfortunately, MH residue data was not available as of this printing.

Acknowledgments

The authors would like to thank the Georgia Agricultural Commodity Commission for Tobacco for financial support. Also, thanks to, Kari Giddens, Adam Mitchell, Justin Odom, Katie Summers and Mitchell Tucker for technical assistance.

Table 1. 2012 Regional Tobacco Growth Regulator Test, Effects of Advanced Growth Regulating Material on Sucker Growth, Cured Leaf Yields, and Value of Flue-Cured Tobacco.

Treatments	Sucker Growth					Cured Leaf			
	% Control	Green Wt./ Plant (g)	No./ Plant	Green Wt./ Sucker (g)	Plant Injury[2]	Yield (lbs/A)	Value ($/A)	Price Index[3] ($/cwt)	Grade Index[4]
1. Topped-Not-Suckered	0	553.1	3.2	172.8	0	2142	3688	172	84
2. CONTACTS[1]/(FAIR 30 & PRIME+ 1.0 GPA & 0.5 GPA)	100	0	0	0	1	2952	5073	172	84
3. CONTACTS /PRIME+(0.5 GPA)/FAIR 30 (1.0 GPA) With SPRAY HOODS	100	0	0	0	1	2993	5059	169	82
4. CONTACTS / PRIME+(0.5 GPA)/FAIR 30 (1.0 GPA)	100	0	0	0	1	2989	5168	172	83
5 CONTACTS /PRIME+(0.5 GPA)/FAIR 30 (0.66 GPA) With SPRAY HOODS	100	0	0	0	1	2970	5061	170	81
6 CONTACTS / PRIME+(0.5 GPA)/FAIR 30 (0.66 GPA)	100	0	0	0	1	2964	5279	178	86
7 CONTACTS / PRIME+(0.5 GPA)/FAIR 30 (0.33 GPA) With SPRAY HOODS	98.9	7.7	0.2	38.5	1	2992	5436	182	87
8 CONTACTS / PRIME+(0.5 GPA)/FAIR 30 (0.33 GPA)	98.9	7.5	0.2	42.9	1	3025	5234	173	84
9 CONTACTS/(FAIR 30 & PRIME+ 0.33 GPA & 0.5 GPA)/Prime + (0.25GPA) With SPRAY HOODS	100	0	0	0	1	2994	5089	173	82

Table 1. 2012 Regional Tobacco Growth Regulator Test, Effects of Advanced Growth Regulating Material on Sucker Growth, Cured Leaf Yields, and Value of Flue-Cured Tobacco (*continued*).

	Treatments	Sucker Growth					Cured Leaf			
		% Control	Green Wt./ Plant (g)	No./ Plant	Green Wt./ Sucker (g)	Plant Injury[2]	Yield (lbs/A)	Value ($/A)	Price Index[3] ($/cwt)	Grade Index[4]
10	CONTACTS /(FAIR 30 & PRIME+ 0.33 GPA & 0.5 GPA)/Prime + (0.25GPA)	99.8	1.7	0.1	22.0	1	3010	4501	150	74
11	CONTACTS / PRIME+ (0.5GPA)/PRIME +(0.25GPA) With SPRAY HOODS	98.3	12.2	0.3	44.2	1	2893	5038	174	84
12	CONTACTS / PRIME+ (0.5GPA)/PRIME +(0.25GPA)	98.3	12.1	0.2	80.7	1	3054	5498	180	87
13	CONTACTS / PRIME+ (0.5GPA)/BUTRALIN(0.25GPA) With SPRAY HOODS	99.1	6.4	0.1	51.2	1	2959	5172	175	85
14	CONTACTS / (PRIME+ 0.5GPA) / BUTRALIN(0.25GPA)	97.0	20.8	0.3	75.5	1	2955	4961	168	82
	LSD-0.05						159.3	647.9	21.3	8.7

[1]All treatments received 3 contact applications with Fair 85 at 4%, 5%, and 5% (2.0 GPA, 2.5 GPA, and 2.5 GPA).
[2]Injury rating on a scale of 0-10 with 0 = no damage and 10 = plant killed.
[3]Price Index based on two year average (2011-2012) prices for U.S. government grades.
[4]Grade Index is a 1-99 rating based on government grade. High ratings are best.
*Mention of a trade name does not constitute a guarantee or warranty of a product by the University of Georgia and does not imply its approval to the exclusion of other products.

Table 1. Tobacco Sucker Control Chemicals (multiple pages)

CHEMICAL TYPE – PROGRAM	CHEMICAL AND FORMULATION	FORMULATION RATE PER ACRE	REMARKS AND PRECAUTIONS
CONTACT	Fatty Alcohol (C_6, C_8, C_{10} and C_{12} alcohol mixture)		Solution concentration and timing of fatty alcohol solutions are very important. Apply the first contact treatment at a 3% concentration (1.5 gal of chemical in 48.5 gal of water) when 30 to 40% of plants are in the early button stage. Make a second contact application at a 4% concentration (2 gal of chemical in 48 gal of water) 5 to 7 days later. Third applications may be made 5 to 7 days later if the crop is not uniform, weather conditions are not suitable for application of maleic hydrazide or if harvest must occur within 7 days. Use approximately 50 gal of solution per acre or enough to provide for spray solution to reach the bottom of the stalk. Use two TG-3 nozzle tips and one TG-5 or equivalents per row with 20 to 25 psi pressure operated from 12 to 16 inches above the top of the button or stalk at 2.5 to 3 mph. **Excess nitrogen or high soil and plant moisture conditions may increase the chance of leaf drop where contact solutions are applied and promotes excess sucker growth.** If the application of contacts starts after the 30 to 40% early button stage, start with 4% and follow 5 to 7 days later with a 5% application. Antak contains only C_{10} alcohol. Because this long chain alcohol is said to be "hotter" than the mixture of alcohols found in the other products the rate is normally reduced 0.5% less than for the products which are mixtures of C_6, C_8, C_{10} and C_{12} alcohols.
	85% Active Ingredient		
	(Various Brands)		
	Fair 85	1.5 - 2.5 gal	
	Off-Shoot T	1.5 - 2.5 gal	
	Royaltac - M	1.5 - 2.5 gal	
	Sucker Plucker	1.5 - 2.5 gal	
	n-Decanol (C_{10}) 79% Active Ingredient		
	Antak	1.5 - 2.25 gal	
SYSTEMIC	Maleic Hydrazide (potassium salt) (MH)Various Brands		- Apply 5-7 days after last contact treatment. -Use 30-40 gal of water per acre and a pump pressure of 25-35 psi. - Apply to upper sides of leaves on upper one third of stalks.
	(1.5 lb MH/gal)		**- Do Not Apply Sucker Control Chemicals When Tobacco Is Wilted or Wet or under Windy Conditions. - Do Not Use Drop Nozzles for Application of MH. - Allow 7 Days or until after Rainfall Between MH Application and Harvest.**
	Fair Plus	1.5 gal	
	Royal MH	1.5 gal	
	Super Sucker Stuff	1.5 gal	
	(2.25 lb MH/gal)		
	Fair 30	1.0 gal	
	Royal MH Xtra	1.0 gal	
	Sucker Stuff	1.0 gal	
	Water-Soluble MH 60% by wt. of MH		**Fair 80 SP** is a water-soluble powder packaged in dissolvable 3.75 lb containers. **Royal MH-30 SG** is a water-soluble granular material packaged in dissolvable 7.5 lb containers. **Sucker Stuff 60 WS** is packaged in water dissolvable packets. Two packets are packaged in one paper over-pack bag weighing 3.75 lbs to provide 2.25 lbs MH.
	Fair 80 SP	5.0 lbs	
	Royal MH-30 SG	5.0 lbs	
	Sucker Stuff60WS	5.0 lbs	

Table 1. Tobacco Sucker Control Chemicals (multiple pages)

CHEMICAL TYPE – PROGRAM	CHEMICAL AND FORMULATION	FORMULATION RATE PER ACRE	REMARKS AND PRECAUTIONS
CONTACT-SYSTEMIC MIX	38.3% ai Fatty alcohol (n-Decanol) and 11.1% ai MH (potassium salt) **FST-7** **Leven-38**	 3.0 gal 3.0 gal	Provides 2.0 lbs ai MH/A and a 4% contact solution. Mix with 47 gal of water and apply approximately 50 gal per acre to plants in early flower stage (one week after button) all day except when plants are wet or temperature exceeds 90°F with bright sunlight. Use three nozzles per row to deliver a coarse spray at 20-25 psi pressure targeted to the upper one third of the plant. Do not apply within 7 days prior to harvest unless irrigation or rainfall will occur to minimize MH residues.
CONTACT-LOCALIZED-SYSTEMIC/ SYSTEMIC COMBINA-TION	**[FLUMETRA-LIN + MH]** [tankmixed] **FLUMETRALIN** (1.2 lb/gal) + **MH** (1.5 lb/gal)] or **MH** (2.25 lb/gal)]	 (2 qt + 1.5 gal) or 1.0 gal)	**FLUMETRALIN (Drexalin Plus, Flupro, or Prime+) TANK MIXED WITH MH** Flumetralin may be tank mixed with the labeled rate of any MH product which does not specifically prohibit the tank mix in approximately 50 gal of water and applied as a contact to run down the stalk (approximately 50 gal solution per acre). Apply 5-7 days after the last application of contact and after a majority of the plants have been topped. Direct spray at 20 to 25 psi into the top leaf axils of plants.
CONTACT-LOCALIZED-SYSTEMIC/ SYSTEMIC COMBINA-TION (Continued)	**FLUMETRALIN** (1.2 lb/gal) + **MH** (1.5 lb/gal) or **MH** (2.25 lb/gal)	2 qt + 1.5 gal or 1.0 gal	**SEQUENTIAL APPLICATION OF FLUMETRALIN (Drexelin Plus, Flupro, or Prime+) WITH MH** Mix 2 qt of flumetralin in 50 gal of water and apply either by handheld dropline nozzles or with powered spray equipment as a contact to run down the stalk. Timing of flumetralin should be during the elongated button to early flower stage of tobacco. Approximately 3 to 5 days after the flumetralin application, apply maleic hydrazide according to the label directions, precautions, and restrictions on that label.

Table 1. Tobacco Sucker Control Chemicals (multiple pages)

CHEMICAL TYPE – PROGRAM	CHEMICAL AND FORMULATION	FORMULATION RATE PER ACRE	REMARKS AND PRECAUTIONS
MH FREE			Apply multiple applications of contacts of increasing concentrations (3% / 4% / 5%) beginning when not more than 30 to 40% of the plants are in the early button stage and continuing on a 5 to 7 day schedule to control early suckers as they emerge and allow the upper plant leaves to more fully develop. Top plants that have flowered after each application.
CONTACT/	Fatty Alcohol 3%/	1.5 gal	
CONTACT/	Fatty Alcohol 4%/	2.0 gal	
CONTACT/	Fatty Alcohol 5%/	2.5 gal	
CONTACT-LOCALIZED-SYSTEMIC/	**FLUMETRALIN/**	2 qt	Apply 30 to 50 gallons of a solution prepared by mixing 2 quarts of flumetralin OR 3 qts of flumetralin in 50 gallons of water per acre with droplines, jugs, or a power sprayer 3 to 5 days following the last contact application. Accuracy of control is improved with hand application using droplines or jugs, but increases the labor requirements. Apply as a contact to run down the stalk. Stalks must be standing straight for the most efficient control.
CONTACT/	Fatty Alcohol 5%/	2.5 gal	
CONTACT	Fatty Alcohol 5%	2.5 gal	
			An additional application of no more than 1 quart of flumetralin applied with a mechanical sprayer may improve long term control by treating untreated leaf axils when applied 5 to 7 days after the initial fluemetralin.application. Additional applications of 5% contact solutions may be required on a 5 to 7 day schedule to provide additional control of missed suckers. Additional hand sucker removal may be required to prevent suckers from becoming unwanted foreign material in the harvested leaf.

Table 1. Tobacco Sucker Control Chemicals (multiple pages)

CHEMICAL TYPE – PROGRAM	CHEMICAL AND FORMULATION	FORMULATION RATE PER ACRE	REMARKS AND PRECAUTIONS
(3 Way TANKMIX)	**[FLUMETRA-LIN + MH + CONTACT]** [3 way tankmix] **[FLUMETRA-LIN**(1.2 lb/gal) + **MH** (1.5 lb/gal) or **MH** (2.25 lb/gal) + **CONTACT]**	 (2 qt + 1.5 gal or 1.0 gal + 2.5 gal)	**FLUMETRALIN (Drexelin Plus, Flupro, or Prime+) TANK MIXED WITH MH and CONTACT** Flumetralin may be tank mixed with the labeled rate of any MH product which does not specifically prohibit the tank mix. To provide additional control a 5% solution of any contact fatty alcohol product may be included by adding 2.5 gallons of product for each 47.5 gallons of total solution. Apply in approximately 50 gal of water per acre as a contact to run down the stalk (approximately 50 gal solution per acre). Apply the three-way tank mix 5-7 days after the last application of contact and after a majority of the plants have been topped. Direct spray at 20 to 25 psi into the top leaf axils of plants. **FST-7** or **Leven-38** may be used in combination with flumetralin to provide MH and Contact material for the 3-Way Tankmix. Following label instructions will result in lower application rates of MH and contact than suggested above.
CONTACT: Late Season Clean-up	Fatty Alcohol (C_6, C_8, C_{10} and C_{12} alcohol mixture) 85% Active Ingredient (Various Brands) **Fair 85** **Off-Shoot T** **Sucker Plucker** **Royaltac-M** n-Decanol (C_{10}) 79% Active Ingredient **Antak**	 2.5 gal 2.5 gal 2.5 gal 2.5 gal 2.25 gal	Late season application (up to 3 weeks after MH or Contact-localized-systemic) of a 5% contact solution (2.5 gal in 47.5 gal water) may be useful in controlling late season sucker growth or suckers uncontrolled by previously applied materials. Use the three nozzle arrangement described above. Care should be taken not to apply this solution in bright sunlight when the temperature is high or when tobacco is moisture stressed.

PROGRAM CODES

CHEMICAL TYPES SEPARATED BY A SLASH "/" SYMBOL MEANS CHEMICAL TYPES ARE APPLIED SEQUENTIALLY OVER TIME. GENERALLY A "/" MEANS 3 TO 5 OR 5 TO 7 DAYS BETWEEN APPLICATION OF LISTED CHEMICAL TYPES.

Table 2. Yellowing Agent for Flue-Cured Tobacco

CHEMICAL TYPE	CHEMICAL AND FORMULATION	RATE PER ACRE	REMARKS AND PRECAUTIONS
YELLOWING AGENT	ethephon **(Ethrel)** 2 lb/gal	2 - 4 qt	Use after second or third priming when remaining leaves are physiologically mature. **Directed Spray:** Mix the lower amount in 50 to 60 gal of water and apply on a warm, sunny day as a fine spray mist with drop nozzles which direct the spray so that all mature leaves are covered. This treatment may make determining which leaves to harvest a little difficult as the tips of some upper leaves may yellow more rapidly than the butts. Harvest all leaves with 20% or more yellowing. **Over the Top:** Use the higher rate in 40 to 60 gal of water for an acreage of coverage. Apply to all remaining leaves on the stalk. Determining time of application requires some experience and some trial and error; therefore, use a test kit to treat a few plants and observe the results before treating the whole field. Harvest yellowed leaves when they reach desired degree of yellowness, usually within 24 to 72 hours. Harvest may be completed the day after treatment. Excessive delay in harvest may result in loss of yield and quality or leaf drop. Tobacco which is sufficiently mature when treated and which yellows prior to harvest may require an advanced curing schedule with reduced yellowing time. Close attention should be paid to the curing schedule.
	ethephon **(MatureXL)** 6 lb/gal	1.33 - 2.66 pt	
	ethephon **(Prep)** 6 lb/gal	1.33 - 2.66 pt	
	ethephon **(Super Boll)** 6 lb/gal	1.33 - 2.66 pt	
	ethephon **(Ethephon 6)** 6 lb/gal	1.33 - 2.66 pt	

APPLYING CONTACTS AND SYSTEMICS FOR SUCKER CONTROL

Paul E. Sumner

Care should be taken when applying contacts and systemics to obtain effective control. When applying contacts, be sure the spray mixture flows down the stalk and into the leaf axils. Use three solid cone nozzles spaced 9 to 12 inches apart over each row. Direct the two outside the nozzles toward the upper one third of the tobacco plant. It is suggested that a larger nozzle be used in the center. Application speed commonly used 3-nozzle arrangement (TG3-TG5-TG3) is limited to 2.5 to 3 mph in order to concentrate the appropriate spray volume over the center of the row. Growers who wish to apply suckercides at faster speeds need uniform row widths, good application equipment and relatively level land that will allow the nozzles to remain over the row and the boom stable at the speed used. When applying contacts sprayers should be calibrated to deliver approximately 50 gallons of mixture per acre at 20 - 25 psi.

Apply systemics to the active growing parts of the tobacco plant. Use solid cone nozzles, spaced 9 to 12 inches apart, over each row. Direct the two outside the nozzles toward the upper one third of the tobacco plant. **DO NOT USE DROP NOZZLES. Apply spray mixture to the top surface of leaves.** Calibrate sprayers to apply 30 to 50 gallons of mixture per acre at 25 - 35 psi. **Do not apply MH materials with less than 30 gallons of water.** There have been cases of plant burn with low rates of water.

Table 3. Suggested spray nozzles for application of contacts and systemics

Type of Material	Nozzle Arrangement	Pressure (PSI)	Speed (MPH)	Row Spacing (inches) 42	44	46	48
Contacts, Localized	TG2-TG3-TG2[1]	20	2.5	55	52	50	48
(Offshoot T, Prime+,		20	3	46	44	42	40
Flupro)	TG2-TG4-TG2	20	3	52	50	48	46
		20	3.5	45	43	41	39
	TG3-TG5-TG3	20	3.5	61	58	56	53
		20	4	53	51	49	48
		20	4.5	47	45	43	41
	TG4-TG6-TG4	20	4	68	65	62	59
		20	4.5	60	58	55	53
		20	5	54	52	50	47
	TG5-TG8-TG5	20	5	70	67	64	61
Systemics	TG3-TG3-TG3	20	3.5	50	47	45	43
(MH Alone)		20	4	43	41	39	38
		20	4.5	38	37	35	34
	TG4-TG4-TG4	20	4	58	56	53	51
		20	4.5	52	49	47	45
		20	5	47	45	43	41
	TG5-TG5-TG5	20	5	59	56	53	51
		20	5.5	53	50	49	47

[1] - TG is the designation for Spraying Systems nozzles. Other nozzle systems are available that may be used.

CALIBRATION METHOD FOR HYDRAULIC BOOM AND BAND SPRAYERS, AND OTHER LIQUID APPLICATORS

Paul E. Sumner

The procedure below is based on spraying 1/128 of an acre per nozzle or row spacing and collecting the spray that would be released during the time it takes to spray the area. Because there are 128 ounces of liquid in 1 gallon, this convenient relationship results in ounces of liquid caught being directly equal to the application rate in gallons per acre.

Calibrate with clean water whenever possible. When applying materials that are appreciably different from water in weight or flow characteristics, such as fertilizer solutions, etc., calibrate with the material to be applied. Exercise extreme care and use protective equipment when active ingredient is involved. Check uniformity of nozzle output across the boom. Collect from each for a known time period. Each nozzle should be within 10 percent of the average output. Replace with new nozzles if necessary.

Step 1. Determine type of application to be made and select appropriate procedure from Table 1. Example: Herbicide Broadcast Procedure B.

Table 1. Calibration for Application of Herbicide, Insecticides, Nematicides Fungicides, or Liquid Fertilizers.

Type of Application	Procedure	Coverage Basis
Row (See Note)	A	Row (gal/acre of row)
Broadcast	B	Broadcast (gal/acre)
Band	C	Broadcast (gal/acre of band

Note: Determine and use average row spacing for modified row patterns. Use width of area covered per row as row spacing in skip row patterns.

Step 2. Using procedure A, B, or C below as selected in Step 1, determine appropriate calibration distance from Table 2.

(A) Row Application: Measure row spacing for evenly spaced rows. Find this row spacing in the left column of Table 2. and read the corresponding calibration distance from the column on the right. Example: for a 38" row spacing, the distance would be 107.5 feet.

(B) Broadcast Application: Outlets or nozzles must be evenly spaced. Measure outlet (nozzle, etc.) spacing. Find this spacing in left column of Table 2. and read the corresponding calibration distance. Example: for a 19" spacing the distance would be 214.9 feet.

(C) Band Application: Measure band width. Find this band width in the left column of Table 2. and read the corresponding calibration distance. Example: for a 12" band, the distance would be 340.3 feet.

Table 2. Calibration Distances for Various Row and Outlet Spacings or Band Widths.

Row Spacing, Outlet Spacing or Band Width (Whichever Applies) (inches)[2]	Calibration Distance Distance[1] (feet)
48	85.8
46	88.8
44	92.8
42	97.2
40	102.1
38	107.5
36	113.4
34	120.1
32	127.6
30	136.1
24	170.2
20	204.2
19	214.9
18	226.9
12	340.3
10	408.4
8	510.5

[1] To determine distance for spacing or band width not listed, divide the spacing or band width expressed in feet into 340.3. Example: for a 13" band the calibration distance would be 340 divided by 13/12 = 314.1.

[2] To increase calibration accuracy for a wide nozzle spacing, multiply calibration distance by a factor (for example, 2); then , divide the fluid amount collected by the same factor for GPA. For narrow nozzle spacings with long calibration distances, divide calibration distance by a factor (for example, 4); then, multiply the fluid amount collected by the same factor for GPA.

Step 3. Measure and mark calibration distance in a typical portion of the field to be sprayed.

Step 4. With all attachments in operation (harrows, planters, etc.) and traveling at the desired operating speed, determine the seconds it takes to travel calibration distance. Be sure machinery is traveling at full operating speed the full length of the calibration distance. Mark or make note of engine RPM. You must operate machine at same speed used for calibration.

Step 5. With sprayer sitting still and operating at same throttle setting or engine R.P.M. as used in Step 4, adjust pressure to the desired setting. Machine must be operated at same pressure used for calibration.

Step 6. PROCEDURE A, Step 2 — **row application**, collect spray from **ALL** outlets (nozzles, etc.) used for one row for the number of seconds required to travel the calibration distance.

PROCEDURE B, Step 2 — **broadcast application**, collect spray from **ONE** nozzle or outlet for the number of seconds required to travel the calibration distance.

PROCEDURE C, Step 2 — **band application**, collect spray from **ALL** nozzles used on one band width.

Step 7. Measure the amount of liquid collected in fluid ounces. **The number of ounces collected is the gallons per acre rate on the coverage basis selected in Table 1**. For example, if you collect 18 ounces using procedure B or C the sprayer will apply 18 gallons per acre on a broadcast coverage basis. Adjust applicator speed, pressure, nozzle size, etc. to get recommended rate. If speed is adjusted, start at Step 4 and recalibrate. If pressure or nozzles are changed, start at Step 5 and recalibrate.

Step 8. To determine amount of pesticide to put into a sprayer or applicator tank, divide the total number of gallons of mixture to be made (tank capacity for a full tank) by the gallons per acre rate from Step 7 and add recommended amount of pesticide for this number of acres.

Step 9. Check for proper calibration every four to eight hours of use. Simply repeat steps 6 and 7. If there is a difference of more than five percent of original calibration, check the system.

Use the recommended **broadcast** rates of pesticide to make tank mixtures for band applications when calibrating with procedure C. The number of gallons/acre determined in Step 7 is the gallons that will be applied to each acre actually treated.

CALCULATING BAND APPLICATION VOLUME

To determine the gallons of spray mixture required to make a band application on a field, determine the number of acres that will be in the actually treated band. When all treated bands are the same width and all untreated bands are the same width, which is usually the case, the acres in the actually treated band can be calculated by placing the width of the treated band over the sum of the widths of the treated band and the untreated band, and multiplying this fraction times the number of acres in the field. Example: How many acres will actually be treated in a 30 acre field if a 12" band of chemical is applied over the drill of rows spaced 36" apart? The treated band width is 12". The untreated band width is (36" - 12") 24".

Acres actually treated will be $\frac{12"}{12" + 24"}$ X 30 acres = 10 acres.

The amount of mixture required will be 10 times the number of gallons per acre from Step 7. The amount of chemical will be 10 times the recommended broadcast rate for one acre.

Check rate recommendations carefully as to application type, broadcast, band or row, and type of material specified, formulated product and active ingredient.

CALCULATING FORMULATION REQUIREMENTS FOR ACTIVE INGREDIENT RATES.

To determine amount of liquid pesticide required for a rate given in pounds of active ingredient per acre, divide recommended rate by pounds active ingredient per gallon stated on label. Example: Pesticide label states 4 lbs. active ingredient per gallon and recommends 1/2 pound active ingredient per acre. Amount of pesticide required: 1/2 lb./A divided by 4 lb./gal. = 1/8 gal./A.

To determine amount of wettable powder required for a rate given in pounds active ingredient per acre, divide recommended rate by percent active ingredient stated on label. Example: Pesticide label states powder is 50% active ingredient. Two pounds of active ingredient is recommended per acre. Amount of pesticide powder required: 2 lbs. AI/A divided by 0.5 AI/lb. = 4 lbs./A.

HARVESTING AND CURING EQUIPMENT MAINTENANCE

Paul E. Sumner, Extension Engineer

Equipment should be serviced and checked to ensure trouble free and efficient operation.

HARVESTERS

All harvester systems and parts should be checked for proper operation. The engine, power train, hydraulic system, tires, etc. should be serviced and checked. Check the condition and tension of drive belts and chains and replace if needed. All adjustment mechanisms should operate freely so that adjustments can be made rapidly and easily in the field.

CURING BARN

The bulk curing barn should have a complete inspection before it is put into heavy use. The fan, thermostat and electrical controls should be cleaned. The capillary tube on thermostats should be checked for kinks and/or breaks. The wicks on wet bulb thermostats should be replaced and reservoirs checked. Belts, bearings and shafts should be checked and replaced if needed. Burner components should be inspected and cleaned and/or replaced if necessary. Check the heat exchangers for cracks and leaks.
Examine these few points to make the coming curing season a fuel efficient one.

LOADING DOORS

Loading doors should be hung such that they will seal the entire opening. Gaskets around the door should be in good condition. Torn or frayed gaskets should be replaced. A good substitute material is thick piled carpet. This material can be easily obtained and installed to seal the loading doors. Water hoses will not withstand the high air temperatures and should not be used.

FOUNDATION

The foundation of bulk curing barns should be sealed with an asphalt sealant. This material will expand and contract as the barn heats up and cools during the curing season. A small crack between foundation and pad area can waste more money in energy loss than the small cost of sealing.

CURING CHAMBER AND FURNACE ROOM AREAS

These areas should be examined closely. Look for small and large cracks. They should be sealed with a butyl caulk or a caulking material that can withstand 180°F air temperatures and remain flexible. One way of detecting air leaks is to go into the barn, close the door and look for daylight. These will be the areas to caulk.

INSULATION

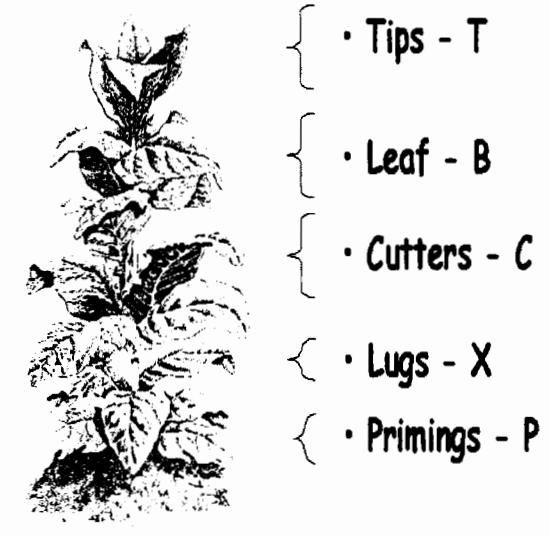
Research has proven that insulating the bulk curing barn will save dollars. Payback for insulating ranges from 1 to 3 curing seasons depending on type of insulation used and area insulated. Utilize an insulating material that will not absorb moisture. This is a key factor since during curing humidity levels reach 100%. If the insulation absorbs moisture, the effectiveness of the insulation will be drastically reduced. Use insulation with an R-Value of 3 or more.

HARVESTING AND CURING

Uniformly ripe tobacco is essential to have top quality leaf for sale. Under normal conditions flue-cued tobacco ripens 2 to 4 leaves per week, therefore a harvest rate of 2 to 4 leaves per plant per week for 5 to 7 weeks is required.

Leaf purchasers have requested that tobacco be cured and sold by stalk position. This can be accomplished by a minimum of 5 harvest/cure cycles. Harvest leaves as follows 1) crop the bottom 2 to 3 leaves called primings, 2) harvest the next 3 to 4 leaves denoted by lugs, 3) gather the next 5 to 6 leaves labeled cutters, 4) crop the next 5 to 6 leaves characterized as leaf and 5) harvest the top 4 to 5 leaves designated as tips. Figure 1 shows a graphic of stalk position.

Tobacco can be harvested by hand or machine. Hand harvesting causes less damage to the tobacco and there is less foreign material (such as sand and sucker) in the cured tobacco. Machine harvest can be accomplished by using defoliators (multiple harvest during the season) and cutter bars (last over or harvest last two stalk positions the same day).



Several factors can influence the maturity and harvest rate. Tobacco grown with recommended fertilizer requirements will tend to ripen normally and produce sufficient pounds. Because of the dirt and closeness to the soil it is recommended that sand lugs (first 2-3 leaves to ripen) not be harvested using machines. Lower stalk tobacco contains more **moisture on a percentage basis than the upper stalk tobacco**. Therefore, the **primings should be harvested when the leaf is dry**. Timely harvest is essential to obtain a quality leaf for market. Harvest primings when the leaves appear to be the same color as those of field peas. Another indicator of ripeness is to hold the leaf up in sunlight and visually look for uniform color (pale green) throughout the leaf.

Figure 1. Flue Cured Stalk Positions

HARVEST ONLY MATURE, RIPE LEAVES

Tobacco leaves reach full maturity a few days before ripening. Mature leaves exhibit a slight yellowing and puckering between veins and break off the stalk easier than immature leaves. Fully mature leaves cure easily, and the quality, color, and weight are usually good. The best quality cures occur when the tobacco is allowed to mature in the field. The stages of maturity are premature, mature, ripe, and overripe. Tobacco harvested in the ripe stage may be cured to give better color, quality and weight than tobacco harvested in the overripe stage. Overripe tobacco does not color, yield, or sell as well as tobacco harvested and cured at proper maturation. You should let the tobacco mature and ripen, but not become too ripe before removing leaves from the stalk.

WHEN TO HARVEST

Care should be taken when harvesting drought stressed tobacco. The middle and butts of the tobacco

leaf will appear to be ripe according to color. But actually, the leaf has not fully matured. Let the leaves stay in the field rather than trying to color them in the barn. But if this type of tobacco is harvested remember to maintain moisture levels in the curing barn high and keep dry bulb temperatures just above (3-5°F) outside temperatures. Once the leaf has yellowed then raise temperature fast enough to fix color and start drying the leaf.

CONTAINER LOADING

Since the introduction of the bulk curing barns, there have been problems with properly loading the bulk containers. It is difficult to get laborers to load containers uniformly, including racks, big boxes, or medium-sized boxes. When packing containers, make sure there are no air tunnels or packed lumps of tobacco. Spread tobacco evenly over the entire container as it is being filled. Lumps or wads of tobacco cause tight spots and the tobacco will not cure properly. Fill the corners and edges of bulk containers first and pack slightly more then the center. Unless there is uniform airflow to all leaves in the container, there will be leaves or pockets of leaves that do not cure.

The type and condition of the tobacco determines to a large extent how tight the tobacco can be packed in bulk containers. **Primings and lugs, if harvested, should not be packed at all.** Just enough tobacco to fill the containers will result in the best cures.

Good quality, upper stalk, dry tobacco can be packed to a density of 15 lb/cu. ft. and get good results. Remember that the density of tobacco may increase from morning to afternoon. Tobacco is usually turgid (swollen with moisture) in the morning, but it may be completely wilted in the afternoon. Do not pack wilted tobacco as tightly as turgid tobacco. Containers should fit snugly together so air does not pass between them. A board or other materials should be used to block air movement between the doors and the outside container.

GUIDE FOR BULK CURING

Curing develops and preserves the potential quality, flavor and aroma of tobacco. Once the tobacco is in the curing barn, a concerted effort to bring the tobacco to a brilliant color (lemon orange) should be made. Once the desired color is achieved, dry out the leaf to preserve that color. Color is important. It indicates the degree of chemical changes that have taken place, and is used as an index of leaf quality. It is estimated that 75 percent of the market value of the leaf is based on the color.

Closely monitor tobacco throughout the curing process to check on temperature, humidity, and condition of tobacco. Look through observation ports at periodic intervals to check the wet-bulb, dry-bulb thermometer and the color changes taking place. Place the wet-bulb, dry-bulb thermometer under the tobacco near an observation port so it will not be necessary to open the doors.

I. START UP:

Close air intake dampers before heater is turned on. Turn heater on and raise temperature to yellowing range gradually. Temperature should not be raised more than 5°F at any one jump. Allow about 30 minutes between temperature rises to provide time for curing air to become humid. If tobacco has free moisture on the leaves at harvest, operate the fan for 12 to 24 hours with vent open to dry the surface before the heater is turned on.

II. YELLOWING:

Yellow at a dry-bulb temperature of 95° to 105°F and wet-bulb of 93° to 97°F. To maintain high humidity and prevent color setting before it is desired, dampers should be almost closed. Maximum drying short of color setting is desirable; however, for fuel economy and for the best cure. Dampers should, therefore be "cracked" open to the maximum extent short of color setting, especially when using boxes. Venting or moisture removal during yellowing will aid air movement through the boxes during leaf drying. Tobacco that is sappy or high in moisture requires considerably more moisture removal before color setting than does drought or low moisture tobacco.

III. WILTING:

Some wilting occurs before the end of yellowing at the 105°F dry-bulb temperature, but most of the wilting should take place as the dry-bulb temperature advances from 110° to 118°F. The rate of temperature advance from 105° to 110°F should be 1° to 1.5°F per hour and wet-bulb of 100°F. During the wilting phase, the tobacco loosens considerably and the air can move through readily. **Do not advance the temperature beyond 118°F dry-bulb temperature until wilting is 100 percent complete.**

IV. LEAF DRYING:

Raise dry bulb temperature 2° per hour to 135°F. Leaf drying is the most critical period of the cure. Time is required for moisture removal to keep up with temperature increases. If tobacco gets too hot, water scalding or sweating will occur.

Ventilation of outside air into the barn should increase during this stage of curing to maintain proper wet-bulb temperature. When the curing temperature is raised above 118°F, the dampers should be open enough to hold wet-bulb down to 100°F. The more the dampers are opened, the lower will be the wet-bulb temperature. Keep dampers open enough to hold wet-bulb temperature of 100° to 105°F throughout leaf drying (100°F for the first

24 hours and 105°F for the final stages). For diseased or extra thin tobacco, a lower wet bulb (90° to 100°F) may produce a brighter cure.

Wet-bulb temperature is the same as the leaf temperature until the leaf has dried. The leaf cell breaks down and browning or scalding occurs at a leaf temperature of 113°F. Thus, the wet-bulb temperature should never be allowed to exceed 110°F until the leaf lamina is completely dry.

V. STEM DRYING:

Raise temperature gradually for stem drying. After leaf is essentially dry, temperature should be raised gradually (2° to 3°F per hour) to 165°F for stem drying without sponging or scalding.

Close dampers gradually during stem drying. Maintain damper opening sufficient to hold wet-bulb temperature down to 110°F during the first 12 to 18 hours of stem drying. Dampers are usually closed completely about the time the leaf is completely dry and the temperature has reached 165°F.

Do not exceed 165°F during stem drying. Sugars caramelize and leaves turn red art excessively high temperatures. The following temperature schedule (dry-bulb, wet-bulb) should prove effective with normal, good quality tobacco. The time can change according to the condition of the tobacco when it begins the cure. Factors which affect time required for curing in certain phases are maturity of tobacco, stalk position of the leaf, the use of ripening agents and weather condition at harvest.

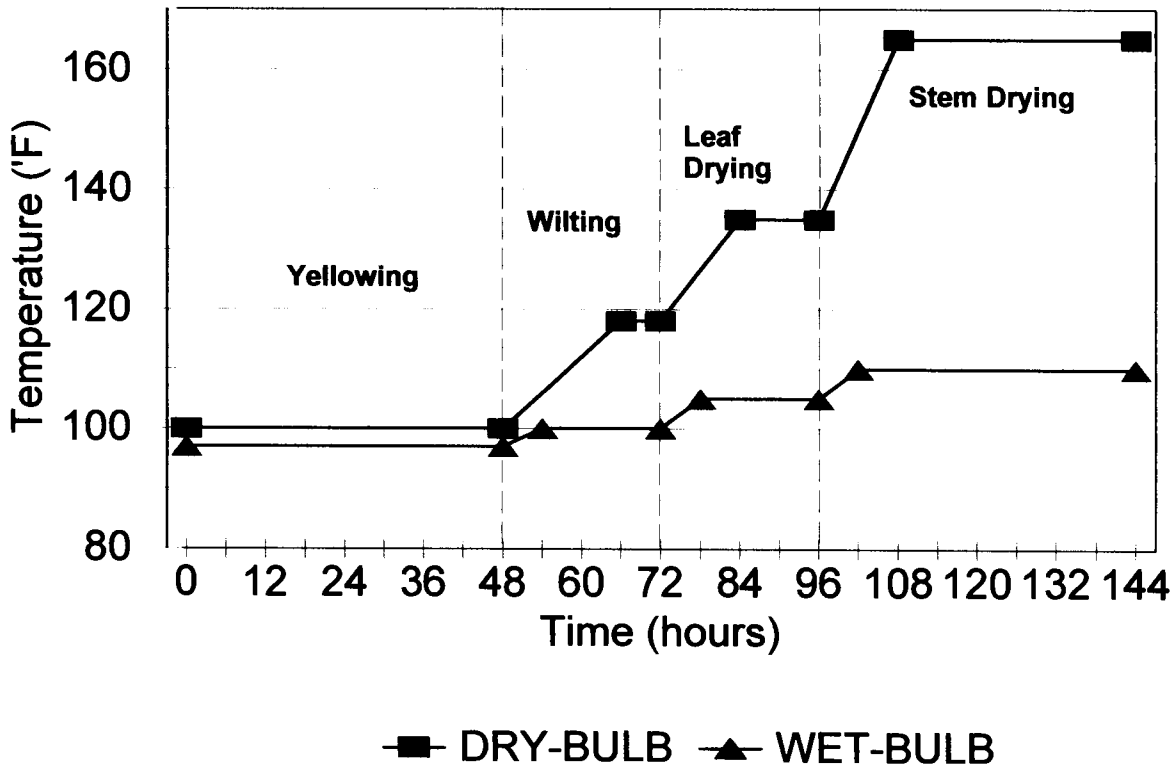


Fig.1. Bulk Curing Schedule for Mature, Ripe Tobacco

DEVIATIONS IN CURED TOBACCO

IMMATURE AND SLICK

Immature, slick tobaccos are described by the trade as lacking in grain and other elements of quality. The surface of the leaf is smooth - does not have the desirable crepe-like texture, and the leaf is papery, with little or no elasticity or oiliness. Such tobaccos lack richness of color, are deficient in aroma, and have a flat undesirable taste. They may be compared with fruits that have been harvested green and allowed to ripen in storage - the "field-ripened" flavor is not there. This condition is associated with such factors as (1) improper fertilization, (2) close spacing or too high topping, with attendant shading and greater competition for plant food, water and sunlight, and (3) excess rainfall or over-irrigation, which leaches out the fertilizer and upsets normal growth processes. These conditions often cause yellowing before ripening, and harvesting of immature leaf. Varieties differ in their tendency to produce tobacco of this type.

GREEN

Green color in the cured leaf results from a failure to break down all the chlorophyll during the curing process. There are several causes of green tobacco:

(1) Harvesting the leaves before they are ripe, as when too many leaves are pulled at once. Tobacco leaves sometimes acquire a faded-out yellow color, suggesting ripeness, which is not true ripeness.

(2) Severe drought conditions, which prevent ripening. Leaves that are harvested under such conditions will generally cure with a greenish cast.

(3) Excessive nitrogen supply, which prevents proper ripening. Tobacco grown with too much available nitrogen will cure out green or brown.

(4) Insufficient yellowing of the leaves before drying.

There are other deficiencies associated with the green color, and such tobacco has a harsh, bitter taste. Lighter shades of green will improve on aging, but pronounced green grades are most undesirable.

SPONGED

The term "sponged" is used to designate those well-grained, porous, overripe tobaccos of a dull, grayish-brown color. This type of cured leaf is caused by allowing tobacco of good quality to become overripe in the field, or by holding low temperatures too long in the early part of the curing process. If the moisture in the leaves is not removed fast enough, sponging is likely to take place - resulting in grayish and brownish blotches on the leaf surface. In normal curing, the color breakdown proceeds from green to yellow. By drying, the color may be fixed at either of these stages. In the case of sponging, the color breakdown has gone beyond the yellow stage to the gray or brown stage. Color, alone, is not the basis for designating tobaccos as sponged - some brown tobaccos may be slick, dead, "toady," or otherwise very undesirable. Slight sponging may not result in serious detriment to quality.

TOADY

The toad is considered by many to be one of nature's ugliest creations. Evidently, men of the tobacco trade had this animal in mind when they selected the term "toady" to describe a very undesirable type of cured leaf. Such tobaccos are characterized by a slick, dense, sometimes thick and leathery, leaf of a nondescript smutty, grayish-brown color. Toady leaves have no grain and are very compact. They are

abnormally high in sugar content. They are usually soggy, but may be dry-natured and starching. The cause of toadiness is not fully understood. However, certain varieties tend to produce higher proportions of this type of leaf than others. It has also been observed that in seasons of high rainfall or following over-irrigation, some toady tobacco may be found in all varieties. The practice of overcrowding curing barns, which prevents rapid drying, seems to favor the development of this condition in tobaccos that have the tendency toward toadiness.

MOISTURE RUN BACK

The presence of dark or reddish areas along the upper portions of the leaf midrib and larger lateral veins is known as "moisture run back" or "circle stem". It is caused by lowering the temperature after the blade of the leaf is dry, but before all moisture has been removed from the midrib. The moisture in the midrib seeps back into the leaf, causing a dark area. Refiring and drying the midrib will not remove the discoloration, but will put the tobacco in safe keeping condition. Run back will not occur if the curing unit is fired continuously until the entire leaf is dry.

BARN SCALD

Dark, chocolate-colored areas on cured leaves, or brown scald, may result from excessive humidity in the curing barn. This condition is usually caused by over-crowding in the barn and inadequate ventilation. The leaves are cooked, rather than dried, when the temperature is raised. Brown scald will also occur in properly loaded barns if killing heat is applied before drying is complete. A set green color, or green scald, may develop in the leaf tips if flash heat occurs before the tobacco is yellowed.

SWELLED STEM

After colors have been developed and the leaf partially dried, at low temperatures ranging from 130 to 145°F., the remaining moisture is removed at "killing out" temperatures of approximately 170°F. Failure to remove all moisture from the midrib leaves it soft, pliable and larger than when dry. Temperature may be too low or held too briefly. Such incompletely-dried midribs are called "swelled stems or "not killed out". Swelled stems usually mold in storage and may be the cause of considerable loss through damage to the surrounding tobacco.

ENERGY EFFICIENT CURING PRACTICES

1) Stop hot air leaks - check door gaskets and structure for cracks. Strips of thick pile carpet can be used.

2) Ventilate only enough to hold humidity down - the wider the vent opening, the more fuel is required. Utilize a wet-bulb thermometer to monitor humidity in the barn.

3) Tune up the fuel burner - periodic maintenance and adjustment is required for efficient operation.

4) Harvest only ripe tobacco - shorter curing time mean less heat loss and more efficient curing. Let tobacco ripen in the field. Do not try to color green, immature tobacco in the barn.

5) Load racks and boxes uniformly - uniform loading with no "tight spots or loose spots" assures even drying and less energy usage.

6) Assure an air seal round each rack or box - a small crack between boxes or racks reduces ventilation efficiency to large degree. Make sure all the air goes through tobacco not around the ends. Utilize boards wrapped with burlap sheets.

7) Add insulation - well-insulated walls, roof and floor can save 10-20 percent of fuel consumed per cure.

8) Use a Curing Guide - "Guide for Bulk Curing Tobacco" can be obtained at the County Extension Office. Each tobacco barn should have one (11"x17") poster near the control box.

ORDERING TOBACCO

Paul E. Sumner

When curing is over and the stems have been killed, the moisture content of the leaves is near zero. At this stage, the leaves and stems are too brittle to handle, so enough moisture must be added to the leaf to bring the moisture content up to about 15 percent. The leaves are then pliable and can be easily handled.

The best way to add moisture back into tobacco is when the temperature of the leaf is high (165°F). The furnace is turned off and a hollow cone spray nozzle operating at 100 psi, if possible, is inserted into the air stream around the furnace. A cured barn of tobacco can be made easy to handle in one to two hours. Table 1. lists different types of hollow cone nozzles and hours of operation to add moisture to cured tobacco.

Table 1. Number of Hollow Cone Nozzles Required to Order a Barn of

Nozzle Type	Pressure (PSI)	Nozzle Operation Time: 2 hrs	4 hrs	6 hrs
		Number of Nozzles Required Per Barn		
TX-3	40	8	4	3
TX-4	40	7	3	2
TX-6	40	4	2	1
D1-13	40	7	3	2
D3-13	40	4	2	1
D1-23	40	6	3	2
D2-23	40	4	2	1
TX-3	100	6	3	2
TX-4	100	4	2	1
TX-6	100	3	1	1
D1-13	100	4	2	1
D2-13	100	3	2	1
D1-23	100	4	2	1

The rate at which to add moisture to the leaf depends mainly on the method selected to add moisture to the barn and on the condition of the tobacco itself. A barn of 3,000 pounds cured tobacco requires about 50 gallons of water to bring the leaf into order. Running the fan with the dampers wide open usually brings the tobacco in order overnight. There are many spray-injection systems that can bring a barn of tobacco in order in a few hours. If there is a floor in the curing barn, water can be poured onto the floor.

No matter which method is selected, do not apply the water directly to the leaf or to the heat exchanger/furnace. Putting water on a hot heat exchanger can cause cracking. Water on a mild steel heat exchanger can cause rusting. The ordering method to use depends on the equipment available and how quickly you need to get the tobacco in order. The use of high pressure (2,000 psi) mist systems and steam are both being evaluated for their usefulness in this process.

RETROFITTING TOBACCO CURING BARNS

Paul E. Sumner, Grant Ellington (NCSU) and J. Michael Moore

Recent research has shown that a class of carcinogenic (cancer-causing) compounds known as tobacco specific nitrosamines (TSNAs) may be formed in flue-cured tobacco leaves during the curing process. These compounds are not found in green (uncured) tobacco. Present research suggests that TSNAs are formed through a chemical reaction between nicotine and other compounds contained in the uncured leaf and various oxides of nitrogen (NOx) found in all combustion gases, regardless of the fuel used. Eliminating NOx compounds in the curing air by using a heat exchanger system has been shown capable of reducing TSNAs to undetectable levels in cured tobacco. The direct-fire curing systems currently in use in most U.S. curing barns are considered to be the major factor contributing to elevated levels of TSNAs in U.S. flue-cured tobacco. Further, there is no known fuel treatment or burner design that can eliminate these nitrogen compounds from combustion gases without the use of a heat exchanger (found in all indirect-fired systems). It is believed that reducing the levels of TSNAs in tobacco products would reduce some of the health concerns associated with tobacco use. An indirect-fired system passes the combustion gases through a heat exchanger and out of the barn, thereby preventing the mixing of flue gases with curing air. Systems with the combustion entirely outside the barn and that conduct the heat to the barn with hot water or steam have proven entirely satisfactory for reducing TSNAs and are acceptable. Research during the 2000 curing season has shown that converting from direct- to indirect-fired curing can reduce levels of TSNAs in cured leaf to *below detectable levels* (less than 0.1 part per million).

OLDER BARNS

Most bulk curing barns built before the mid-1970s were indirect-fired. They had a heat exchanger and flue that directed the combustion gases out of the barn (fuel oil burners). A number of these barns are still in use. Some tobacco samples taken from these older indirect-fired barns during the 2000 curing season were found to have very low to undetectable levels of TSNAs. This does not mean that all older heat exchanger barns will produce satisfactory tobacco. Some samples taken from other older indirect-fired barns were found to have TSNA levels approaching those found in direct-fired barns. This suggests that the heat exchangers and flues in these barns may have cracks or holes that allow combustion gases to escape into the barn. *This is unacceptable.* Growers planning to use older heat exchanger barns should closely inspect them for leaks by using smoke bombs or lights. Your oil or gas dealership representative may be able to help you with this inspection. It is necessary to completely replace the heat exchanger and/or the burners if the old ones are no longer in good working order or cannot be repaired.

MAKING YOUR OWN RETROFIT

After evaluating the design, price, and availability of commercial retrofits, some growers built their own or contracted with a local fabrication shop to build units for them. All of these homemade units tested so far have proven satisfactory in lowering the levels of TSNAs in the cured leaf. Additionally, many are relatively efficient in terms of fuel use and apparently have good airflow characteristics. Unfortunately some homemade units have proven uneconomical due to a less than adequate heat exchange area. Stack

temperatures (the temperature of the flue gases at a point just as they exit the heat exchanger) have exceeded 1000°F in some cases, allowing most of the heat to escape the barn. Other homemade units have experienced warping and cracking where poor design or material selection did not allow for thermal expansion during firing. If you build your own, be sure to use a design and materials proven reliable in the severe thermal cycling conditions of a curing barn.

CONSIDERATIONS FOR SELECTING THE RIGHT RETROFIT FOR YOUR BARNS

With the many different retrofit designs on the market and the limited time available to make a decision, choosing the best one for your particular situation may be difficult. Further, some companies that contract directly with growers to purchase their tobacco may specify which barn and/or burner system must be used. Other buying companies have stated that they have no preference as long as the system substantially reduces the levels of TSNAs in the tobacco and otherwise complies with the specifications and recommendations of the Tobacco Leadership Group. In either case, growers who anticipate contracting, now or in the future, should ask potential buyers about any such specifications.

Experience during the 2000 - 2001 curing season has shown that the place to start looking for a suitable retrofit is with the manufacturer of your barns. This company should have more detailed information on the heat and airflow characteristics required to give a satisfactory cure with your equipment. This has not always been possible, however, since some barn manufacturers are no longer in business or are not offering retrofits at this time. If you find yourself in this situation, you may want to closely review the following points.

FUEL TYPE

LP (liquified petroleum) gas is a by-product of the natural gas industry and consists primarily of propane and butane. It contains approximately 90,500 Btu per gallon. Fuel oil contains approximately 138,000 Btu per gallon. A gallon of fuel oil contains about one and one half times as much energy as a gallon of LP gas. The cost per gallon of both LP and fuel oil fluctuates from season to season and year to year. Because they may be freely substituted in many applications, they do, however, tend to track each other and cost about the same most of the time. Locally, you may be able to find LP gas cheaper than fuel oil (on a cost-per-Btu basis) this year, but next year may be the opposite. The best prices for either type of fuel are to be had by contract buying in bulk lots.

HEAT EXCHANGER COMPOSITION

Commercial heat exchangers for curing barns are presently made of carbon steel, aluminum-coated carbon steel (aluminized steel), one of several grades of stainless steel, or a combination of materials. There are potential benefits and liabilities associated with each. Stainless steel is more resistant to rust and corrosion than carbon steel, so it is less likely to rust or burn out during the expected life of the barn. However, the heat transfer of stainless steel is only about 25 percent that of carbon steel of the same thickness. To compensate for lower heat transfer, a stainless steel heat exchanger would have to be made of thinner material and/or have a greater surface area than one made of carbon steel. On the other hand, a carbon steel heat exchanger could be twice as thick as a stainless steel heat exchanger of the same design and still have better heat transfer characteristics.

A heat exchanger in a bulk curing barn may experience several thousand heating/cooling cycles during a six- or seven-day cure. All metals expand and contract upon heating and cooling, but stainless steel expands and contracts twice as much as carbon steel. Thermal cycling was the prime cause of failure experienced with some stainless steel heat exchangers during the 2000 curing season. No crack failures have been reported with carbon steel heat exchangers. Cracks defeat the purpose of a heat exchanger

because they allow combustion gases to enter the curing barn and contact the tobacco. Before you select a heat exchanger, be sure to closely question the manufacturer concerning thermal cycling and any report of cracks. Some tobacco samples taken from indirect-fired barns during the 2000 curing season had elevated levels of TSNAs traced to cracked heat exchangers. Use the same method described above for testing older heat exchanger barns if you suspect a cracked new heat exchanger.

AIRFLOW

Any heat exchanger will produce some resistance and therefore reduce airflow through the barn to some extent. While most manufacturers have been careful to avoid designs and installations that restrict airflow, the minimal restriction in some cases may lengthen the curing time or contribute to curing problems such as scald, swelled stems, or barn rot. If you have had such problems with a barn before retrofitting, these problems may be more likely after retrofitting. There are only two remedies for poor airflow. The easiest remedy may be to reduce air resistance by reducing the amount of tobacco in the barn. Often even a 5 or 10 percent reduction can have a big effect on the airflow. The other remedy is to increase the airflow. This may be done by increasing the fan rpm or by increasing the angle on the fan blades. In some cases an entirely new, more aggressive fan blade may be necessary. Note that increasing the rpm or fan angle will increase the horsepower and hence amp draw to the fan motor. A competent electrician should check your fan with an amp meter. If it is already at or near the nameplate-rated amperage, you must replace the motor with one of a larger horsepower rating before you change the fan or fan rpm. Operating an electric motor above its rated amperage for even a short period is dangerous and will result in rapid burnout of the motor. ***Remember that no matter how good the barn, retrofit, or tobacco, if you cannot get air to the tobacco, you cannot cure it. Barn rot, in particular, results in extremely high levels of TSNAs in the cured tobacco and completely negates the effects of retrofitting.***

Experience with retrofitted barns during the 2000 - 2001 curing season has shown that vent settings may need to be altered to maintain the proper wet-bulb temperature. Although a few growers reported that the same or slightly less vent opening was required during leaf drying, many needed somewhat more opening to compensate for the air resistance of the heat exchanger. After a cure or two, most growers were comfortable with the new vent settings and pleased with the results. The use of wet-bulb thermometers and curing charts are helpful in determining the optimum vent openings at various stages of the cure.

HEATING SYSTEM EFFICIENCY

The barn heating system consists of a burner and a heat exchanger. The direct-fired gas and oil burners used in curing barns before the retrofit project are very efficient because all the heat produced mixes freely with the curing air. There is no heat exchanger to direct the products of combustion along with some lost portion of the heat out of the barn. Since some heat loss is unavoidable with a heat exchanger, it is very important to gain as much efficiency as possible to control fuel costs. Energy efficiency, by definition, is the percentage of total energy inputted into the system that is put to practical use. In a burner/heat exchanger system, efficiency is complicated by the combination of many interrelated factors.

ENERGY EFFICIENCY OF THE BURNER

Combustion is essentially a chemical process. A burner facilitates the conversion of the chemical energy contained in the fuel to heat. All fuels contain a certain and fixed heat content per unit measure. As an example, if an LP gas burner were 100 percent efficient, it would produce 90,500 Btu for each gallon of LP gas burned. In practice, some portion of the fuel passes through the burner unburned and is therefore wasted. A well-designed and -maintained burner limits this waste to no more than one or two percent.

The greatest reason for burner inefficiency is too little or too much air. In theory, a precise quantity of air is required to completely burn a precise quantity of fuel. Because of incomplete mixing, a limited but very important amount of *excess air* is required to get complete burning and the highest efficiency. When too little air is present, the burner will smoke. The smoke being partially unburned fuel. Smoke not only wastes fuel but can deposit soot inside the heat exchanger, where it acts as insulation. Even a thin coating of soot can considerably reduce heat exchanger efficiency. When too much air is present, the excess air cools the combustion gases and carries heat out before it can be captured by the heat exchanger. Adjusting the correct air-fuel ratio on a burner is essentially the same as adjusting the air-fuel ratio on an engine carburetor. Although an approximately correct burner air-fuel ratio may be set by eye (a blue instead of orange flame), the proper air-fuel ratio can be best achieved with a *combustion analyzer*. Combustion analyzers range in price from $500 to $5,000, are quick and easy to use, and can save a grower hundreds to thousands of dollars per year in wasted fuel. Some fuel dealers and retrofit manufacturers have these instruments for use in adjusting the burners of retrofitted barns. In addition, your local Cooperative Extension agent has access to combustion analyzers and can test your barns at no cost.

ENERGY EFFICIENCY OF THE HEAT EXCHANGER

The energy efficiency of the heat exchanger is the percentage of the total heat entering from the burner that is extracted (exchanged) for practical use inside the barn. For the heat to be exchanged from the burning flue gases, it must pass through the walls of the heat exchanger. Many factors influence the exchange capacity and hence the efficiency of the heat exchanger. These include shape and size of the heat exchanger, its material type and thickness, the rate of hot gases flowing inside the heat exchanger, and the rate of air flowing over the outside surfaces of the heat exchanger.

Additionally, the rate of heat generation (Btu/hr) by the burner greatly influences the efficiency of a particular heat exchanger. A burner operating at a high capacity can easily overwhelm a modest heat exchanger designed for a smaller burner. Most modern fuel oil and LP gas burners are adjustable in capacity (Btu/hr) over a considerable range. For the most efficient operation, balance the burner and heat exchanger. The burner/heat exchanger system will operate most efficiently when the burner is operating at the lowest capacity that will allow the barn to maintain the desired temperature. The early part of leaf drying (barn temperature between 125°F and 135°F) is the part of the cure when the barn requires the most heat. Adjust the heat output of the burner so that the burner is operating nearly continually during this time. For example, a burner that is on for a minute and off for several minutes is probably operating at too high Btu/hr setting and inefficiently overwhelming the heat exchanger. Further, in the short time the burner is operating, the heat exchanger may be getting too hot, inducing severe thermal stresses in the metal and ultimately shortening its life.

CURING EFFICIENCY

While heating system efficiency is the combined efficiency of the burner and heat exchanger, *curing efficiency* takes into consideration the entire process of tobacco curing. In essence, barn efficiency is the bottom line that is often conveniently expressed in terms of pounds of tobacco cured per gallon of oil or gas consumed. Considerable research has established that, on average, a well-maintained and -operated direct-fired barn will cure approximately 9 pounds of cured leaf per gallon of LP gas (or approximately 13 pounds per gallon of fuel oil). These numbers may vary considerably even in the same barn over a curing season because they are affected by such factors as barn loading rates, stalk position, weather conditions, the condition of the tobacco, and variations in vent settings, among others.

Because some of the heat is lost up the stack with a heat exchanger, a burner/heat exchanger delivering the same amount of heat (Btu/hr) to the curing barn as was delivered by a direct-fired system will necessarily require more fuel. In fact, many growers have reported using slightly more fuel. Others, however, reported no increase in fuel use or even that their retrofitted barns used less fuel. There are several possible explanations, with the most likely being that many of the direct-fired burners needed maintenance and adjustments.

One of the quickest and easiest ways to check the efficiency of a burner and heat exchanger is to measure the temperature of the flue gases. To get an accurate reading, you can make a small hole (about 5/16-inch) in the flue at a point just as it comes from the heat exchanger. This opening may be conveniently plugged after the test with a short 3/8-inch bolt. Because the hot flue gases quickly cool as they pass up the stack, taking the temperature at the top will give an erroneously low temperature. Likewise, simply measuring the temperature of the metal flue itself will yield a temperature much lower than that of the flue gases. With the barn warmed to a moderate temperature (140°F) and the Btu/hr output of the burner adjusted so that it can complete the cure in a reasonable time, the ideal stack temperature for LP should be 350°F to 400°F. If you measure the stack temperature before the barn warms up or if the Btu/hr output of the burner is adjusted too low, the reading may be in error.

CAREFUL INSTALLATION IS IMPORTANT

Not all retrofits will properly fit all barns. Proper selection, planning, and installation should reduce the probability of poor airflow and of too little or too much heat, as well as the possibility of explosions and barn fires. Some heat exchanger surfaces may exceed 1200°F, but wood ignites at approximately 450°F. It is very important to make sure that all wood is a safe distance from heated metal surfaces.

There was a significant increase in barn fires in 2001. These fires could have been caused by improper installation of the heat exchangers. Inspect your units of any metal surfaces coming in close contact to wood. If you suspect a problem, replace a wooden member with a steel one would be a simple effective solution. Check for any construction debris or materials used during installation that may have been left in the barn. Vent pipes should be extended a minimum of 2 feet above the highest point of the structure. Single wall vent pipe should have a minimum of 18 inches clearance of any wooden material. Double wall vent pipe can have a 3 inch clearance.

Since the purpose of indirect-fired curing systems is to prevent contact of combustion gases with the tobacco in the barn, do not allow exhaust fumes from burners, boilers, tractors, and other equipment to enter the curing chamber. When the intake vents are open, the barn fan can pull the exhaust fumes into the barn and possibly result in increased TSNA levels. Because these exhaust gases have mixed with outside air, the effect on TSNA levels would not be as great as would be expected with direct-fired burners. Nevertheless, this source could be eliminated or reduced by using smokestacks or flues that release the gases well above the barn roof, and by not allowing tractors or other equipment to operate for extended periods near the intake vents of the barn.

CURING PROBLEMS

Indirect-fired barns have a drier heat and in some cases less airflow. This has caused frustration during curing. The drier heat results in lower moisture levels within the barn for the same vent settings. A wet-bulb thermometer can be used to monitor the moisture levels within the curing barn. By following a suggested curing schedule such as the one included above and comparing the dry bulb temperature to that of the wet-bulb vent settings may be adjusted appropriately during the cure, especially during yellowing and leaf drying.

You can buy wet-bulb thermometers at most fuel supply dealers, or you can make one at a fraction of the cost. A homemade wet-bulb thermometer designed especially for bulk tobacco barns can be used. Details for construction and a photograph of the homemade wet-bulb thermometer are available at http://www.caes.uga.edu/commodities/fieldcrops/tobacco/

DETECTING HEAT EXCHANGER LEAKS

Nitrosomines in the cured leaf became an issue for growers in late 1999. Since that date all of the flue-cured bulk tobacco barns being used have been updated with indirect fired curing units. These units were built by major tobacco barn manufacturers and local metal shops. The life of these units depends on the metal used and quality of construction.

Two full harvest and curing seasons has past for the retrofitted bulk barns. Tobacco companies have been sampling the cured leaf for nitrsomine levels in the cured leaf. Nitrsomine levels in cured leaf have been greatly reduced. But, there have been cases where high nitrosomine levels were found and the growers were notified of the problem. Some reasons for high nitrosomine levels still being detected in cured leaf are as follows:

1. The flue gas exit point is less than 2 feet above the highest point of the barn. Growers should make sure that flue gases are not allowed to enter the barn through the air inlet vents during curing.

2. The welds in and on the metal heat exchanger may have separated (cracked). This could be a result of thin metal being used, more than one type of metal used, poor welds, and inappropriate bracing. These heat exchangers experience several thousand heating/cooling cycles during a six- or seven-day cure. All metals expand and contract upon heating and cooling.

How Do I Find Cracks ?

Use a flash light look at the heat exchanger welds, this may take crawling under the floor and looking down over the furnace area. It will be very hard to examine all of the welds. A better way is use an electronic gas meter to detect carbon dioxide gases (CO_2)being released into the curing air. Recently, North Carolina State University (Grant Ellington) has conducted tests using a commercial gas meter to measure CO_2 in the curing barn. Any CO_2 meter measuring the gas in the range of 0-10,000 ppm can be used. Also, the probe must be placed in the area where the heated air first moves over the furnace. The only requirement is to operate the barn at 120°F for 30-45 minutes. This can be done during the off season. Levels over 1,000 ppm would indicate problems.

If high CO_2 levels or cracks are observed, contact the installer and/or manufacturer of heat exchanger. Under the agreement, they are to repair the unit for three years.

STORING CURED TOBACCO TO MAINTAIN QUALITY

J. Michael Moore and David Jones

Storing excess tobacco from one season until it can be sold the next season requires a continuation of the management used to produce, harvest and cure the tobacco. Continuous management is necessary to maintain low moisture levels in the tobacco and to prevent tobacco moths and cigarette beetles from infesting the stored tobacco.

INTRODUCTION

Good management is required on the part of growers to maintain the quality and value of tobacco which is stored from one season to another. In general, tobacco should be stored in a clean, dry, insect free facility, such as a packhouse or bulk curing barn. The costs of production, harvesting, and curing of carryover tobacco have already been invested and the carryover tobacco is additional profit for the producer if quality is maintained by proper storage. Care should be taken to insure that the tobacco is sufficiently dry when placed in storage. Storage facilities should be maintained insect free and the tobacco should be checked periodically to insure proper storage and the absence of insect or moisture damage. If damaged tobacco is located, steps should be taken to minimize the amount of tobacco damaged.

STORAGE

If space is available tobacco may be left in the curing racks or boxes for storage. Following the curing process the curing barn is probably the most sanitary facility on the farm having eliminated the threat of insects existing in the barn. However, once the barn is opened and tobacco moved in or out new insect contamination may occur. The same may happen over time with the natural movement of insects. Tobacco should be stored in bulk curing barns in the boxes or racks used for curing if at all possible. Avoid storing tobacco in compressed bales. Damage has resulted from areas with excessive moisture in the bales and from the combining of tobacco from multiple stalk positions.

Baled tobacco is hard to bring back into order or case. Tobacco which cannot be left in the barns should be stored in sheets and the tobacco should be dry throughout the sheet when placed in storage. Care should be taken to provide good ventilation under and around the tobacco. Stack sheets no more than 2 sheets high on wooden pallets or rails, especially if the storage area floor is concrete, asphalt or near ground level. A vapor barrier of polyethylene or roofing paper placed on the floor will reduce the infiltration of moisture. Leave space to move around the stacks when making periodic checks every 2-4 weeks.

If bulk curing barns are used the fans may be run occasionally on days when the weather would encourage drying of the tobacco to insure the tobacco remains dry. Tobacco may be redried at temperatures not to exceed 100° F to avoid color changes and reductions in quality. Heat treatment of loosely packed DRY tobacco at 140° F for one hour may be used to reduce the number of insects initially. No residual effect of this treatment should be expected. Tobacco may be reinfested by insects at a later date and may require re-treatment.

INSECTS

Tobacco moths and the cigarette beetle, commonly attack tobacco stored on the farm.

Of these the tobacco moth is most serious. The larvae, which cause all of the damage, are pinkish to yellow to off-white caterpillars about 1/2 inch long. They burrow into and form ragged holes in the cured leaves. Entire leaves may be consumed except for the midrib and large veins. The larvae also deposit webbing and fecal pellets on the infested tobacco. The adult tobacco moth is a small gray moth about 3/8 inch long with a 5/8 inch wingspread.

Cigarette beetle adults are light to dark-brown, hump-backed insects about 1/8 inch long. Adults leave tiny holes as they emerge from pupae cases within the tobacco. The hairy C-shaped larvae, which cause most of the damage, are whitish with a brown head and are about 1/5 inch long. They leave behind powdery waste which can give tobacco an unpleasant flavor.

CONTROL OF INSECTS IN STORED TOBACCO

Control of established infestations is difficult, so prevention is very important. The most important step in prevention is sanitation. Before tobacco is placed in storage, a clean storage area should be prepared. Clean out and burn all tobacco and debris from the storage area. Plant trash in the storage area might harbor insects which can move to the tobacco.

Tobacco Moths: The tobacco and the storage area should also be treated with Bacillus thuringiensis to help prevent tobacco moth infestation. Apply a fine spray to loose tobacco AS IT IS BEING SHEETED. One suggestion might be apply B.t. as a fine mist as the tobacco is sent through a conditioning cylinder (a tumbler).

Rates for treatment with B.t. are as follows:

Tobacco: 2.5 teaspoons Dipel 2X, Dipel DF, or Biobit HP per quart of water per 100 pounds of tobacco. Use 1½ to 5 tablespoons of Mattch per quart of water per 100 pounds of tobacco.

Storage area only: 6 teaspoons Dipel 2X, Dipel DF, or Biobit HP per 2½ gallons of water. Use ½ gallon per 1,000 square feet of surface area.

Stored tobacco should be checked every two to four weeks during the fall and winter for signs of insects and new damage. If tobacco moths are found, tobacco should be treated with B.t. as described above. Treating the outside of piles and/or the sheets will probably not control an established infestation. Piles must be taken apart and the tobacco treated as loose leaves before resheeting. Sheets may also be treated.

Cigarette Beetles: Malathion is labeled for treatment of storage facilities as a residual spray for the control of cigarette beetles. There are no labeled cigarette beetle preventive insecticides for direct application to tobacco.

Treat the storage area only as follows: Storage area only: Malathion 5 lb/gal EC - 1 pt per 2.5 gallons of water Clean the area thoroughly; spray walls, floors, and ceilings to the point of run-off, preferably at least two weeks before storing tobacco.

If cigarette beetles are found in stored tobacco, tobacco may be fumigated. Current regulations make it very difficult for farmers to legally carry out fumigation on their own. Therefore, fumigation should be done by a professional. Some fumigants give an off flavor to the tobacco and are not recommended.

ALL FUMIGANTS ARE VERY HAZARDOUS AND MUST BE HANDLED CAREFULLY.

Remember that fumigation controls only insects which are present; it is not a preventive treatment. Most fumigants can cause damage to metals, especially copper wiring in motors, when in contact at high concentrations. DO NOT treat stored tobacco with pesticides not specifically labeled for this purpose. Always READ and FOLLOW label instructions.

The use of heat in the curing barn to kill infesting insects, as directed above, is the safest and simplest method to eliminate insects in cured tobacco. To simplify this process tobacco which will be stored through the winter should be left in the curing barn in the curing racks or boxes. Regular inspection of the tobacco and occasional use of the barn fan and/or furnace will maintain low moisture content and reduce the potential for insect infestation. For further information contact your local County Extension office.

SUMMARY

Store carryover tobacco in curing barns in boxes or racks used for curing. Barns are the most sanitary facilities on the farm at the end of the curing cycle. Barn fans and heat can be used to manage moisture, insects and mold. Make regular inspections of stored tobacco with special attention following major weather changes.

Avoid storing tobacco in compressed bales. Any tobacco not stored in curing barns and containers should be stored as dry as possible in loosely filled NEW sheets which are not stacked over 2 sheets high. Cover sheeted tobacco with NEW sheets. Sanitation of the tobacco and the surroundings is critical.

Avoid any possible contamination of carryover tobacco with insects (cigarette beetles and tobacco moths) from old tobacco sheets, OLD stored tobacco, tobacco trash or other sources of food for insects. Storage facilities other than curing barns should be cleaned thoroughly to remove tobacco trash, dust and insects from all cracks and crevices. Provide a moisture barrier under sheeted tobacco. Avoid storing sheets on concrete or asphalt.

Store only tobacco which has been cured in a barn with an indirect heat source as all tobacco will have to be certified as low nitrosamines. Only store tobacco in retrofitted barns to avoid exposure to exhaust gases when drying tobacco.

Tobacco warehouses must be bonded and insured if they store tobacco belonging to more than one other person. Consider the effort required to manage stored tobacco not stored on the farm. Most warehouses have cement or asphalt floors requiring tobacco to be stored on pallets to avoid absorption of moisture.

SAFE HANDLING OF PESTICIDES

Paul E. Sumner

Whether you are a farmer or commercial applicator, proper transportation and storage are important aspects of safe pesticide use.

TRANSPORTATION

Pesticides should never be transported inside the passenger compartment of an automobile or truck cab; put them in the trunk or in the back of the truck. Never transport pesticides where they could come in contact with groceries, livestock feed or other products which might become contaminated. A vehicle carrying more than 1,000 pounds of material classed as a "Hazardous Material" must have a placard attached to it.

When transporting pesticides in a truck, see that they are secured to prevent spillage or loss due to sudden starts, stops, turns, etc. Should there be an accident or spill, immediately inform the local police and fire officials of the quantity and name of the pesticide involved. Large spills, particularly of "Restricted Use Pesticides," should be reported to the Georgia Department of Natural Resources, Environmental Protection Division (EPD) (1-404-656-4300), CHEMTREC (1-800-424-9300) and/or the manufacturer.

Applicators of pesticides, particularly in heavily populated areas, must take special precautions to secure products, transported to the application site. Allowing containers of pesticides to remain unattended on the back of an open truck is inviting an accident -- and a costly lawsuit.

Commercial transporters of pesticides must meet special requirements: vehicles must carry placards, bills of lading, labels of the product, etc. Consult the Georgia Department of Transportation regarding these requirements.

STORAGE

Nearly three-fourths of all pesticide accidents involve nonusers of the materials. Many of these involve children. In addition, each year there are several cases of livestock and pet poisonings from contact with improperly stored pesticides. These accidents not only cause human suffering and economic losses, but improper storage is contrary to federal regulations. READ THE LABEL: IT IS THE LAW.

Whether you are a homeowner, producer or applicator of pesticide, there are basic safe storage rules to follow:

1) Keep pesticides, other poisons, and related materials locked in a cabinet, room or separate building designated solely for the storage of these materials. Metal storage cabinets, such as discarded school lockers, provide excellent storage for homeowners or other users of small amounts of pesticides.
2) Post the facilities with a sign: "PESTICIDES - POISONS, KEEP OUT," or similar signs.
3) Control access to this facility to highly trusted, responsible and informed individuals.
4) Never store pesticides where food, feed, seed, fertilizers or other products can become contaminated.
5) Store pesticides in their original containers. It is the law.
6) The facility should be reasonably fireproof and well ventilated. Temperatures should be kept between freezing and 100 degrees F.
7) Sealed concrete floors, concrete block wall and metal shelves are recommended over wooden structures.

8) With shelf storage, store dry pesticides on the top shelves, liquids on the lower shelves.
9) Electrical fixtures should be of the dust- and explosion-proof type.
10) Provide adequate space for the secure storage of empty pesticide containers until proper disposal.

MIXING AND LOADING

Mixing and loading pesticides are among the most dangerous tasks involving work with these products, because it is at this time that people are working with open containers of concentrated pesticides.

For this reason, individuals employed to perform this activity should be well-informed of the dangers involved and work under the supervision of a properly certified, licensed applicator whenever handling "Restricted-Use Pesticides."

Mixing and loading should never be done without a full understanding of the pesticide label and with the use of all recommended personal protective equipment. The label will identify the dangers involved and the precautions to follow, may indicate the signs and symptoms of poisoning and recommend first aid practices, should one be exposed to the product.

Before you begin to mix, load and apply pesticides, and after you understand the label directions, make certain you have taken the following precautions:

1) Have detergent or soap and an adequate supply of water available.
2) Know the early symptoms of poisoning for the pesticide you are using.
3) Know the first aid procedures and make certain that materials and supplies are available.
4) Be certain that materials are available to handle spills.
5) Make certain that all equipment is functioning properly.
6) Do not work alone; be sure help is available if you get into trouble.
7) Have all the recommended protective clothing and equipment. Double-check that the respirator fits properly and has the correct canister cartridge.
8) Never eat, drink, smoke, or go the bathroom while working with pesticides, without first washing your hands.

You are now ready to begin mixing and loading. Follow these suggestions:

1) Reread the label and follow the directions; pay special attention to the warnings and precautions.
2) Make sure only authorized mixers, loaders and/or supervisors are in the mixing and loading area. No other people or animals should be there.
3) Work only in a well-ventilated, well-lighted area.
4) Pesticide containers should be in a secure position when opening, to prevent any spillage. Be sure everyone is wearing the proper personal protective equipment.
5) Mix and pour concentrated pesticides down low, preferably below waist level. Never pour pesticides at eye level. A spill or splash could be disastrous. Always remove clothing and wash yourself and your clothing thoroughly, immediately (within two minutes), if pesticides are spilled or splashed on you.
6) Stand with your back to the wind -- upwind -- so that any fumes or dusts are blown away from you.
7) Pour the pesticide into water, never water into the pesticide.
8) If stirring is necessary, use a stir stick, never your hands.
9) Mix and load on a concrete slab where spills can be contained. Avoid mixing or loading near surface water or near a well-head.
10) Never pour pesticide directly into a spray tank. Always mix and dilute in a small container.

11) When pouring, keep your head well above the spray tank, to prevent pesticides from splashing in your face. Protect your eyes with splash-proof goggles.
12) Never overflow a spray tank. The cleanup could be an all-day, all-night task, costly and dangerous.

After the mixing-loading task has been completed, your responsibility continues:

1) Securely close pesticide containers immediately after use. Return unused pesticide to its proper storage.
2) Clean up all spills, no matter how small the amount.
3) Wash mixing and loading pails, measuring devices and stirring equipment or tools in strong detergent water, rinse in clear water, air-dry and store.
4) Wash your personal protective equipment in detergent, rinse and hang to air-dry.
5) The wash and rinse water used in steps 3 and 4 can best be disposed of by pouring it into the spray tank. Do not overfill the spray tank, so that there will be room for the rinse water.
6) Remove your clothing and launder separately with heavy-duty liquid detergent and hot water. DO NOT USE BLEACH as it could cause a dangerous chemical reaction. Line-dry the clothing where it is exposed to sunlight.
7) Take a hot shower using a detergent-type soap. Do not forget to wash your hair. Put on clean clothing.

APPLICATION

When applying pesticides, you are not generally exposed to the same high concentration of pesticide as during the mixing and loading operation. However, the time-length of exposure is much longer, thus the cumulative exposure may be equal to or greater than during the mixing-loading operation.

Pesticide applications are made with everything from hand sprayers and dusters, to irrigation equipment and aircraft. Whatever equipment is used, many of the safety precautions are the same. These include:

1) Read and follow the label. Applications made which vary from label requirements are a violation of federal law.
2) Use the correct equipment, and make sure it is properly maintained and adjusted. Screens, strainers and nozzles should be clean and functioning properly. Nozzles should be of the right type and properly adjusted and all lines, valves, seals should be checked for leaks.
3) The application equipment should be accurately calibrated on a regular basis. Whenever you have any suspicion that the equipment is applying an inaccurate amount, recalibrate it. Information on calibration is provided within this guide.
4) Wear the proper protective clothing and equipment.
5) Check the weather forecast frequently to determine if conditions will be favorable for the application and effectiveness of the pesticide. The National Weather Service provides a continuously updated weather forecast.
6) Avoid spraying near sensitive areas where drift could damage neighboring crops or the environment. When spraying must be done in these areas, attempt to spray when the air is still, humidity is high and any potential drift will be away from sensitive areas.
7) Lower pressures, proper boom and nozzle adjustments, larger nozzle size and drift reducing additives (if the label permits) will reduce drift.
8) Do not make field adjustments to the sprayer in a recently sprayed, still-wet area. Move to an unsprayed area.
9) Never attempt to clean a nozzle, screen or hose by blowing or sucking on it with your mouth. Use small soft-bristle brushes and/or an air pressure bulb for these purposes.

10) Always empty a tank by spraying the entire contents onto the vegetation or other area for which it was intended. Never drain a spray tank onto the ground. Important: Never mix more than you need!

PESTICIDE CONTAINERS AND DISPOSAL

Paul E. Sumner

Pesticide containers have become one of the major issues with county landfills. The 1976 Resource Conservation and Recovery Act (RCRA) and 1979 Georgia Hazard waste Management Act define the current laws concerning this issue.

PROHIBITED

It is against the law to open dump pesticide containers (rinsed or not). The pouring of rinse water, unused mixtures or unused concentrates onto the ground or water is illegal. These constitute the generation of hazardous waste.

CONTAINER DISPOSAL

In order for pesticide containers to be classified as solid waste rather than hazardous waste the pesticide containers must be properly rinsed. Once the container can be classified as a solid waste product it can be legally disposed at a sanitary landfill. In the case of liquid pesticide, the containers must be immediately rinsed after the seal has been broken on the container. After the container is cleaned, it should be punctured and/or crushed. Applicators have two options available to clean containers.

PRESSURE RINSE

A pressure rinse nozzle screws into a hose as does a garden nozzle, but it is much heavier, has a sharp point for puncturing the container, and sprays water in several directions to ensure good rinsing. To pressure rinse, allow the container to drain into the spray tank for 30 seconds. While holding the container over the tank opening, rinse the cap, threads and exterior of the container. Next, insert the probe of a pressure rinse nozzle into the bottom of the container. For plastic containers, insert near corner or edge of bottom. For metal containers, make an initial hole through bottom with punch or chisel (especially larger than 5 gallon sizes) then insert through hole. Turn rinse unit "ON" to allow water to rinse container. Rotate nozzle slowly allowing water to reach all sides of container and continue to flush for sufficient time (20-30 seconds) to allow adequate rinsing of container. Turn water "OFF." Allow all rinsed contents to drain from the container into the spray tank. Remove the nozzle from the container. The container has been sufficiently cleaned.

TRIPLE RINSE METHOD

Drain the container for 30 - 60 seconds into the spray tank. While holding the container over the tank opening, rinse the cap, threads and exterior of the container. Fill the container $^1/_4$ to $^1/_5$ full of water. Replace the cap and vigorously shake for 30 seconds. Remove the cap and drain the contents into spray tank for 30 seconds. Repeat this rinsing two more times. Puncture and/or crush the container to ensure it will not be used again.

BAG DISPOSAL

Empty contents of bag into the applicator tank or hopper until all the pesticide has been removed. Tear open the container to make sure it is completely empty. Wrap the container in paper and place in a solid waste collection system or carry to a sanitary landfill. It is illegal to dispose of these by open burning in Georgia.

DISPOSAL OF UNUSED MIXTURES

Try not to mix up more than is needed. If spray mixture is left over, spray onto a labeled crop or site. One option is to leave the spray mixture in the tank of the sprayer. This is undesirable since some pesticides will break down not long after mixing, some are corrosive of equipment if not flushed out, and user may forget what was left in the tank. Another option is to transfer unused mixture into a rinsate holding tank. The tank should be label of chemical type and crop sprayed on. This can then be used as make up water for subsequent tank mixtures. Only 20 percent of rinsate can be used for make up water and the rest must be clean water.

CLEANING OUT SPRAYER TANKS, LINES AND NOZZLES

Approximately 40 to 70 gallons of clean water is required to clean 4 - 12 gallons of mixture from a spray tank. This mixture can then be sprayed out over a labeled crop or site. Or collect spray mixture and hold in rinsate tanks.

WARNING

While Environmental Protection Division approves the various recommendations for the disposal of containers, it is possible local landfills may have further restrictions. Locally owned or run landfills have the right of refusal.

RECYCLING EMPTY CONTAINERS

A number of counties in Georgia have been participating in a pesticide container recycling program. This program is sponsored by the University of Georgia Cooperative Extension Service, Georgia Department of Agriculture and the Agricultural Chemical Association of Georgia. In counties who have the program, clean containers are brought to an initial inspection site and collected. This may be the local landfill, airport or other designated site for container collection. The clean containers are stored until the container granulator can be brought to the site for chipping the containers. The resulting material is used in the making of more pesticide containers.

For more information on starting a container recycling program in your area, contact the Georgia Department of Agriculture (229) 386-3142.

PESTICIDE RECORDKEEPING REQUIREMENTS

Paul E. Sumner

USDA released the final ruling on pesticide recordkeeping requirements for private applicators of Restricted Use Pesticides (RUPs). The requirements became effective and enforceable May 10, 1993.

These regulations mostly impact private applicators because, commercial applicators were already required to keep records. However, the new regulations now require commercial applicators to provide a copy of their RUP pesticide application records to the client within 30 days.

Here is a summary of requirements for private applicators. Applicators must record the following information for federal RUPS:

- the month, day, and year of the application
- the pesticide brand or product name
- the EPA registration number
- the crop, commodity, stored product, or site that received the application
- the total amount of RUP applied
- size of the area treated
- name and certification number of the certified applicator
- location of the application

Records must be kept two years after application. Information should be recorded within 30 days of application. There is no required form. There is no reporting requirement. However, records must be submitted if requested by:

- USDA
- Georgia Department of Agriculture
- Licensed health care professional who requires the information to treat a person who may have been exposed to the RUP for which the record is maintained.

The law provides for penalties for failure to keep RUP records. For the first violation, the penalty is not to exceed $500. For subsequent violations, penalties will not be less than $1000, unless it is determined that a good-faith effort had been made to comply.

Restricted Use Pesticide Recordkeeping Form

Month/ Day/ Year	Crop	Pesticide brand name, EPA registration number	Total amount applied	Location of application	Applicator's name and certification number	Size of area treated	Notes of any unusual occurrence[1]

[1] Notes of any unusual occurrence such as wind speed and direction, weather, crop status, pest, equipment, etc.

FARM MACHINERY SAFETY

Glen C. Rains

Everyone realizes the danger involved in working with agricultural equipment. But it bears keeping in mind the ease with which we fail to take the necessary precautions after a long day or while our minds wonder while we are performing A routine maintenance on a piece of equipment, or moving equipment over public highways. Here are safety tips that cover three of the most important areas of farm safety: 1) PTO safety 2) tractor and equipment safety and 3) road travel safety.

PTO Safety

1. Keep all PTO shielding in-place.
2. Repair or replace damaged shielding.
3. NEVER step over a PTO driveline.
4. Wear close fitting clothing and keep loose hair under a cap or tied back.
5. Disengage PTO before dismounting from tractor.
6. Keep children and non-workers clear of operating machinery.
7. Inspect the PTO regularly and provide proper maintenance to keep it operating smoothly.

Tractor and Equipment Safety

1. If not equipped, retrofit ROPS (Rollover Protective Structure) onto tractors.
2. Use seatbelts with ROPS.
3. Do not allow "extra riders", especially children.
4. Shut down equipment, turn off engine, remove key and wait for moving parts to stop before dismounting.
5. Make sure everyone who operates a tractor or other equipment has received training and is physically able to operate equipment safely.
6. Read operator's manual and pay attention to warning decals.
7. Use caution when operating a tractor on any slope.
8. Remain alert and focused on the tasks at hand, especially when performing maintenance and repairs.
9. Hitch only to the drawbar and hitch points recommended by tractor manufacturers.

Road Travel Safety

1. Use Slow Moving Vehicle Emblem.
2. Use retro-reflective tape on the sides and back of farm vehicles on the highway.
3. ALWAYS wear your seat belt when traveling on the highway.
4. Use caution when turning left, some motorists may try to pass on the left side when you slow down.
5. Utilize pilot vehicles on the highway.
6. Be aware of road conditions, especially curves, hills, crossroads, and bridges.

There are also some general safety tips that should be followed to respond to accidents when they do occur:

1. Keep a first aid kit and fire extinguisher accessible at all locations.
2. Make sure all emergency numbers are posted near phones and that everyone knows where phones are located.
3. It is a very good idea to get trained in cardio-pulmonary resuscitation (CPR).
4. Develop an emergency response plan.

If you are interested in looking for more safety information, please look to the following Internet sites:

http://www.ncfh.org/ -	This is the National Center for Farmworker Health
http://www.nsc.org/issues/agrisafe.htm -	National Safety Council site for Agricultural Safety
http://www.ag.ohio-state.edu/~agsafety/NIFS/nifs.htm -	National Institute for Farm Safety
http://www.cdc.gov/niosh/topics/agriculture/ -	A site that contains national, and state statistics on agriculturally related accidents

WORKER PROTECTION STANDARD

Paul E. Sumner

In August 1992, the Environmental Protection Agency (EPA) revised its Worker Protection Standard (WPS) for Agricultural Pesticides. The WPS governs pesticides used in the production of agricultural plants on farms and in forest, nurseries, and greenhouses. The WPS has provisions for informing agricultural workers and pesticide handlers about pesticide regulations. WPS provisions took effect on January 1, 1995.

If you are uncertain of how the WPS applies to you, contact the EPA regional office in Atlanta ((404) 347-5201) or Gempler's (1-800-382-8473) to obtain a copy EPA How to Comply manual. Listed below are basic requirements of the WPS.

PESTICIDE APPLICATION LIST

The employer must display a list of pesticide applications and make it accessible in a central location to agricultural workers and pesticide handlers employed on the establishment.

NOTIFYING AGRICULTURAL WORKERS OF PESTICIDE APPLICATIONS

Agricultural workers must be notified of pesticide applications. In most cases, the employer can choose to notify workers either verbally or by posting the field warning sign at the entrances to the pesticide treated area.

Some product labels will require both verbal and posted notification. When the label allows the employer to choose the type of notification, workers must be told which type is being used.

VERBAL NOTIFICATION CONTENT

Agricultural workers must be told the location and description of treated area; the time when entry is restricted; and not to enter the treated area until the REI has expired.
This information must be provided in a way workers can understand.

TIMING OF POSTED NOTIFICATION

Field warning signs can be displayed no sooner than 24 hours before the scheduled application and must remain displayed throughout the application. The signs must be removed within three days after the REI or after the end of the application in cases where no REI exists. Agricultural workers may not be permitted to enter the treated area until the signs are removed.

EXCEPTIONS TO PROVIDING NOTIFICATION TO WORKERS

Agricultural workers need not be notified about pesticide application in the cases:

(A) On farms when no agricultural workers will be in the treated area or will walk within 1/4 mile of that area during the pesticide application or during the REI.
(B) When the agricultural worker who applied (or supervised the application of) the pesticide knows the information required to be provided in the notification.
(C) When no agricultural workers will be in a greenhouse when pesticides are being applied or during REI.

The pesticide label will give actual requirements for PPE needed to apply the material. Always read the label first before mixing and applying any pesticide.

Worker Protection Standards for Agricultural Pesticides Used in Tobacco Production

J. Michael Moore

The U.S. Environmental Protection Agency Worker Protection Standard is a regulation that requires actions by employers 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 and comply with its requirements. To plan effectively, you must also understand how compliance might affect your operation.

To fulfill the requirements imposed by the Standard, you must protect workers and pesticide applicators in three ways:

1. **Provide training on pesticide safety and information about the specific pesticides used on the farm.** 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, active ingredient, time and date of application, restricted-entry interval, and the time when workers may reenter the field).

2. **Ensure protection against exposure.** Employers must provide personal protective equipment and be sure it is properly used and cleaned. They must also warn workers about treated areas (through oral warnings, posting of fields, or both) and make sure 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 requirements vary from pesticide to pesticide and may be different for applicator/handlers and mixer/loaders. Protective equipment also is required for entry into fields during the restricted-entry interval. Check labels carefully for specific requirements. Restricted-entry intervals also vary by pesticide and are given on labels (generally 4, 12, 24, or 48 hours).

3. **Provide ways for workers to mitigate or minimize the impacts of pesticide exposure.** This includes making available decontamination sites and emergency assistance in case of exposure. For full information on the Worker Protection Standard, consult your local Cooperative Extension agent.

The following table lists products, registration numbers, common names, restricted entry intervals, and posting/notification requirements for the major pesticides and growth regulators used in tobacco. This should help you to properly record and post pesticide use and to plan field operations. Remember, however, that the information in this table is presented in good faith as a reference. 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.***

Note: **Changes to labels can occur at any time; this information *does not* take the place of the product label. *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)**		**Worker Notification [2]**	
			Applicators and Other Handlers	**To Enter Treated Area Within REI**	**Oral**	**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;chemical-resistant gloves for all mixers and loaders; shoes plus socks	coveralls; chemical-resistant gloves made of any waterproof material such as polyethylene or polyvinyl chloride; shoes plus socks; chemical-resistant headgear for overhead exposure	either	either
Acrobat® MZ *(dimethomorph & mancozeb)* EPA Reg. No. 241-383 BASF Corporation	Caution	24 hrs.	coveralls over long-sleeved shirt and long pants; waterproof gloves; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either
Actara 25 WDG (thiamethoxam) EPA Reg. No. 100-938 Syngenta Crop Protection	Caution	12 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either
Actigard 50 WG (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 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 2 F (imidacloprid) EPA Reg. No. 264-758 Bayer CropScience	Caution	12 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves made of any waterproof material such as, barrier laminate, butyl rubber, nitrile rubber, neoprene rubber, natural rubber, polyethylene, polyvinylchloride (PVC) or viton; shoes plus socks	chemical-resistant gloves made of any waterproof material such as, barrier laminate, butyl rubber, nitrile rubber, neoprene rubber, natural rubber, polyethylene, polyvinylchloride (PVC) or viton; 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)		Worker Notification [2]	
			Applicators and Other Handlers	To Enter Treated Area Within REI	Oral	Posted
Admire® Pro (imidacloprid) EPA Reg. No. 264-827 Bayer CropScience	Caution	12 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves made of any waterproof material such as, barrier laminate, butyl rubber, nitrile rubber, neoprene rubber, natural rubber, polyethylene, polyvinylchloride (PVC) or viton; shoes plus socks	coveralls, chemical-resistant gloves made of any waterproof material such as, barrier laminate, butyl rubber, nitrile rubber, neoprene rubber, natural rubber, polyethylene, polyvinylchloride (PVC) or viton; shoes plus socks	either	either
Advise™ 2FL *(imidacloprid)* EPA Reg. No. 42750-110-1381 Agriliance, LLC	Caution	12 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves made of any waterproof material such as, barrier laminate, butyl rubber, nitrile rubber, natural rubber polyethylene, polyvinylchloride (PVC) or Viton; shoes plus socks	coveralls; chemical-resistant gloves made of any waterproof material such as, barrier laminate, butyl rubber, nitrile rubber, natural rubber polyethylene, polyvinylchloride (PVC) or Viton; shoes plus socks	either	either
Agree® *(Bacillus thuringiensis subspecies* aizawai*)* EPA Reg. No. 70051-47 Certis USA, L.L.C.	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
Aim *(Carfentrazone)* EPA Reg. No. 279-3241 FMC Corporation	Caution	12 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either
Alias™ 2F *(imidacloprid)* EPA Reg. No. 264-758-66222 MANA - Makhteshim Agan of North America, Inc.	Caution	12 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves made of any waterproof material such as, barrier laminate, butyl rubber, nitrile rubber, natural rubber polyethylene, polyvinylchloride (PVC) or Viton; shoes plus socks	coveralls; chemical-resistant gloves made of any waterproof material such as, barrier laminate, butyl rubber, nitrile rubber, natural rubber polyethylene, polyvinylchloride (PVC) or Viton; shoes plus socks	either	either
Antak® (C10 fatty alcohol) EPA Reg. No. 19713-18 Drexel Chemical Co.	Warning	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; waterproof gloves; 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)		Worker Notification [2]	
			Applicators and Other Handlers	To Enter Treated Area Within REI	Oral	Posted
Assail 70WP *(Acetamiprid)* EPA Reg. No. 8033-23-4581 Cerexagri **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
Baythroid® XL (Cyfluthrin) EPA Reg. No. 264-840 Bayer CropScience LP	Warning	12 hrs.	long-sleeved shirt and long pants, chemical-resistant gloves, such as Barrier Laminate or Nitrile Rubber or Neoprene Rubber or Viton, shoes plus socks, and protective eyewear.	coveralls, chemical-resistant gloves, such as barrier laminate or nitrile rubber or neoprene rubber or viton, shoes plus socks and protective eyewear.	either	either
Belay 16WSG *(Clothianidin)* EPA Reg. No. 66330-52 Arysta LifeScience	Caution	12 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks	coveralls; waterproof gloves; 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
Besiege™ (Lambda-cyhalothrin + Chlorantraniliprole) EPA Reg. No. 100-1402 + EPA Reg. No. 100-NE-001 Syngenta	Warning	24 hrs.	long-sleeved shirt and long pants, chemical-resistant gloves, Category C, such as barrier laminate; butyl rubber ≥ 14 mils; or nitrile rubber ≥ 14 mils; neoprene rubber ≥ 14 mils; polyvinyl chloride (PVC) ≥ 14 mils; or Viton ≥ 14 mils; and shoes plus socks.	coveralls, chemical-resistant gloves, Category C, such as barrier laminate; butyl rubber ≥ 14 mils; or nitrile rubber ≥ 14 mils; neoprene rubber ≥ 14 mils; polyvinyl chloride (PVC) ≥ 14 mils; or Viton ≥ 14 mils; and shoes plus socks.	either	either
Biobit HP *(Bacillus thuringiensis* subspecies *kurstaki)* EPA Reg. No. 73049-54 Valent BioSciences Corporation	Caution	4 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)		Worker Notification [2]	
			Applicators and Other Handlers	To Enter Treated Area Within REI	Oral	Posted
Blackhawk™ (Spinosad) EPA Reg. No. 62719-523 Dow AgroSciences	Caution	4 hrs.	long-sleeved shirt and long pants; shoes plus socks; chemical-resistant gloves (such as natural rubber, selection category A)	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-resistant gloves, such as Barrier Laminate or Nitrile Rubber or Neoprene Rubber or Viton, shoes plus socks, and protective eyewear.	coveralls, chemical-resistant gloves, such as barrier laminate or nitrile rubber or neoprene rubber or viton, and shoes plus socks.	either	either
Brom-O-Gas® (95% methyl bromide) EPA Reg. No. 5785-4, -42 Great Lakes Chemical Corporation	Danger	48 hrs. and gas concentration less than 5 ppm	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	non-handlers prohibited	yes	yes
Butralin FC (butralin) EPA Reg. No. 33688-4-400 Crompton/Uniroyal	Danger	12 hrs.	long-sleeved shirts and long pants; chemical-resistant gloves; shoes and socks; and protective eyewear	coveralls; chemical-resistant gloves; shoes and socks; and protective eyewear	either	either
Check M15 (maleic hydrazide) EPA Reg. No. 19713-20-5549 Coastal Chemical	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
Chlor-O-Pic® (99% chloropicrin) EPA Reg. No. 5785-17 Great Lakes Chemical Corporation	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; full-face shield or safety glasses with brow and temple shields. Do not wear goggles.	Non-handlers prohibited	yes	yes
Chloropicrin 100® (99% chloropicrin) EPA Reg.No. 8536- 02-8853 Hendrix & Dail	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; full-face shield or safety glasses with brow and temple shields. Do not wear goggles.	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)		Worker Notification [2]	
			Applicators and Other Handlers	To Enter Treated Area Within REI	Oral	Posted
Chlorpyrifos® 4E AG (chlorpyrifos) EPA Reg. No. 19713-520 Drexel Chemical Co. EPA Reg. No. 66222-19 Makhteshim Agan of N.A. EPA Reg. No. 51036-291 Micro Flo Company LLC	Warning	24 hrs.	Coveralls over short -sleeved shirt and short pants; chemical-resistant gloves; chemical-resistant shoes plus socks; protective eyewear; chemical resistant headgear for overhead exposure; chemical-resistant apron when cheaning equipment and mixing and loading	coveralls; chemical-resistant gloves; shoes plus socks	either	NR
Chlorpyrifos® 15 G (chlorpyrifos) EPA Reg. No. 19713-505 Drexel Chemical Co.	Caution	24 hrs.	long-sleeved shirt and long pants; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	NR
Chlorpyrifos® 15 G AG (chlorpyrifos) EPA Reg. No. 51036-300 Micro Flo Company LLC	Caution	24 hrs.	long-sleeved shirt and long pants; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	NR
Command® 3ME (clomazone) EPA Reg. No. 279-3158 FMC Corporation	Caution	12 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves, such as barrier laminate or viton; shoes plus socks; and protective eyewear.	coveralls; chemical-resistant gloves, such as barrier laminate or viton; shoes plus socks; and protective eyewear.	either	either
Coragen® SC (*chlorantraniliprole*) EPA Reg. No. 352-729 Dupont	none	4 hrs.	long-sleeved shirt and long pants; shoes plus socks	long-sleeved shirt and long pants; 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)		Worker Notification [2]	
			Applicators and Other Handlers	To Enter Treated Area Within REI	Oral	Posted
Couraze™ 2F *(imidacloprid)* EPA Reg. No. 264758-67760 Cheminova, Inc.	Caution	12 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves made of any waterproof material such as, barrier laminate, butyl rubber, nitrile rubber, natural rubber polyethylene, polyvinylchloride (PVC) or Viton; shoes plus socks	coveralls; chemical-resistant gloves made of any waterproof material such as, barrier laminate, butyl rubber, nitrile rubber, neoprene rubber, natural rubber polyethylene, polyvinylchloride (PVC) or Viton; shoes plus socks	either	either
Crymax® (*Bacillus thuringiensis* subspecies *kurstaki* EG7841 Lepidopteran active toxin) EPA Reg. No.70051-86 Certis USA, LLC	Caution	4 hrs.	long-sleeved shirt and long pants; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either
Deliver (*Bacillus thuringiensis* subspecies *kurstaki)* EPA Reg. No. 70051-69 Certis USA, LLC	Caution	4 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either
Denim 0.16 EC (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, such as barrier laminate, butyl rubber ≥ 14 mil, nitrile rubber ≥ 14 mil, neoprene rubber ≥ 14 mil, polyvinyl chloride (PVC) ≥ 14 mil, or viton ≥ 14 mil; chemical-resistant footwear plus socks; protective eyewear; chemical-resistant apron when cleaning equipment, mixing or loading	coveralls worn over long-sleeved shirt and long pants; chemical-resistant gloves, such as barrier laminate, butyl rubber ≥ 14 mil, nitrile rubber ≥ 14 mil, neoprene rubber ≥ 14 mil, polyvinyl chloride (PVC) ≥ 14 mil, or viton ≥ 14 mil; chemical-resistant footwear plus socks; protective eyewear	either	either
Devrinol® 2-EC (napropamide) EPA Reg. No. 70506-64 United Phosphorus Inc.	Danger	12 hrs.	long-sleeved shirt and long pants; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)		Worker Notification [2]	
			Applicators and Other Handlers	To Enter Treated Area Within REI	Oral	Posted
Devrinol® 50-DF (napropamide) EPA Reg. No. 70506-36 United Phosphorus Inc.	Caution	12 hrs.	long-sleeved shirt and long pants; waterproof gloves, shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either
DiPel DF *(Bacillus thuringiensis* var *kurstaki)* EPA Reg. No. 73049-39 Valent BioSciences Corporation	Caution	4 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either
DiPel ES *(Bacillus thuringiensis* var *kurstaki)* EPA Reg. No. 73049-17 Valent BioSciences Corporation	Caution	4 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves such as barrier laminate, nitrile rubber, neoprene rubber, or viton; shoes plus socks	coveralls; chemical-resistant gloves such as barrier laminate, nitrile rubber, neoprene rubber, or viton; shoes plus socks	either	either
Di-Syston® 8 E (disulfoton) EPA Reg. No. 3125-307 Bayer CropScience	Danger Poison	48 hrs.	coveralls over long-sleeved shirt and long pants; chemical-resistant gloves; chemical-resistant footwear plus socks; protective eyewear; chemical-resistant headgear; chemical resistant apron; respirator	coveralls over long-sleeved shirt and long pants; waterproof gloves; chemical-resistant footwear plus socks; chemical-resistant headgear for overhead exposure	yes	yes
Di-Syston® 15 G (disulfoton) EPA Reg. No. 264-723 Bayer CropScience	Danger Poison	48 hrs.	coveralls over short-sleeved shirt and short pants; waterproof gloves; chemical-resistant footwear plus socks; chemical-resistant headgear; chemical-resistant apron; respirator	coveralls over short-sleeved shirt and short pants; waterproof gloves; chemical-resistant footwear plus socks; chemical-resistant headgear for overhead exposure	yes	yes
Dithane DF Rainshield (mancozeb) EPA Reg. No. 707-180 Rohm and Haas	Caution	24 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves such as butyl rubber or nitrile rubber or neoprene rubber or viton; shoes plus socks; chemical-resistant apron when cleaning equipment, mixing or loading	coveralls over long-sleeved shirt and long pants; chemical-resistant gloves, such as butyl rubber or nitrile rubber or neoprene rubber or viton; 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)		Worker Notification [2]	
			Applicators and Other Handlers	To Enter Treated Area Within REI	Oral	Posted
Durivo (Thiamethoxam + Chlorantraniliprole) EPA Reg. No. 100-1318 Syngenta Crop Protection	Caution	12 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves, Category C, such as barrier laminate; butyl rubber ≥ 14 mils; or nitrile rubber ≥ 14 mils; neoprene rubber ≥ 14 mils; polyvinyl chloride (PVC) ≥ 14 mils; or Viton ≥ 14 mils; and shoes plus socks.	coveralls; chemical-resistant gloves, Category C, such as barrier laminate; butyl rubber ≥ 14 mils; or nitrile rubber ≥ 14 mils; neoprene rubber ≥ 14 mils; polyvinyl chloride (PVC) ≥ 14 mils; or Viton ≥ 14 mils; and shoes plus socks.	either	either
Fair Plus® (maleic hydrazide) EPA Reg. No. 51873-2 Fair Products, Inc.	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
Fair-30® (maleic hydrazide) EPA Reg. No. 51873-9 Fair Products, Inc.	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
Fair 80 SP® (maleic hydrazide) EPA Reg. No. 51873-17 Fair Products, Inc.	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
Fair 85® (C6, C8, C10, C12 fatty alcohols) EPA Reg. No. 51873-7 Fair Products, Inc.	Warning	24 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves made of any waterproof material, such as nitrile, butyl, Neoprene, or barrier laminate or butyl rubber or nitrile rubber or neoprene; shoes plus socks	long-sleeved shirt and long pants; chemical-resistant gloves such as barrier laminate or butyl rubber or nitrile rubber or neoprene; shoes plus socks; protective eyewear	either	either
Flupro (flumetralin) EPA Reg. No. 73631-2-400 Chemtura Corporation	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 (go	either	either
Forum™ *(dimethomorph)* EPA Reg. No. 241-427 BASF Corporation	Caution	12 hrs.	long-sleeved shirt and long pants; chemical resistant gloves made of any waterproof material, such as polyethelene or poly vinl chloide; shoes plus socks	long-sleeved shirt and long pants; chemical resistant gloves made of any waterproof material, such as polyethelene or poly vinl chloide; 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)		Worker Notification [2]	
			Applicators and Other Handlers	To Enter Treated Area Within REI	Oral	Posted
FST-7® (C10 fatty alcohol and maleic hydrazide) EPA Reg. No. 51873-6 Fair Products, Inc.	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 (pymetrozine) EPA Reg. No. 100-912 Syngenta	Caution	12 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks	either	either
Furadan® 4 F (carbofuran) EPA Reg. No. 279-2876 FMC Corporation **Registration Voluntarily Cancelled**	Poison	48 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 when mixing or loading; respirator; when using closed systems, enclosed cabs, or aircraft in a manner that meets WPS requirements, the PPE requirements may be reduced or modified.	coveralls; chemical resistant gloves; shoes plus socks	yes	yes
Furadan® LFR (carbofuran) EPA Reg. No. 279-3310 FMC Corporation **Registration Voluntarily Cancelled**	Poison	48 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 when mixing or loading; respirator; when using closed systems, enclosed cabs, or aircraft in a manner that meets WPS requirements, the PPE requirements may be reduced or modified.	coveralls; chemical resistant gloves, such as Barrier Laminate or Butile Rubber, or Nitrile Rubber or Neoprene Rubber or Polyvinyl Chloride or Viton; 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)		Worker Notification [2]	
			Applicators and Other Handlers	To Enter Treated Area Within REI	Oral	Posted
Golden Leaf ® Tobacco Spray® (endosulfan) EPA Reg. No. 66222-63 Makhteshim-Agan of NA **NO LONGER RECOMMENDED FOR USE ON TOBACCO**	Danger-Poison	24 hrs.	Coveralls over long-sleeved shirt and long pants; chemical-resistant gloves; chemical-resistant footwear plus socks; protective eyewear; chemical-resistant headgear; a respirator with either organic vapor -removing cartridge with prefilter approved for pesticides, or a canister approved for pesticides, or a NIOSH approved respirator with an organic vapor cartridge or canister with any N, R, P, or HE prefilter. Mixers and/or loaders must wear a chemical-resistant apron in addition to all the protective equipment specified for applicators	Coveralls over long-sleeved shirt and long pants; chemical-resistant gloves; chemical-resistant footwear plus socks; protective eyewear; chemical-resistant headgear	either	either
Imida E-Ag 2F *(imidacloprid)* EPA Reg. No. 81959-22 ETIGRA™ LLC	Caution	12 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves made of any waterproof material such as, barrier laminate, butyl rubber, nitrile rubber, natural rubber polyethylene, polyvinylchloride (PVC) or Viton; shoes plus socks	coveralls; chemical-resistant gloves made of any waterproof material such as, barrier laminate, butyl rubber, nitrile rubber, natural rubber polyethylene, polyvinylchloride (PVC) or Viton; shoes plus socks; protective eyewear when working in a non-ventilated space	either	either
Javelin® WG (*Bacillus thuringiensis*, subspecies *kurstaki*) EPA Reg. No.70051-66 Certis USA, LLC	Caution	4 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either
Karate with Zeon Technology™ Insecticide (lambda-cyhalothrin) EPA Reg. No. 100-1097 Syngenta Crop Protection	Warning	24 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves, such as barrier laminate or butyl rubber, nitrile rubber or viton ≥ 14 mils; shoes plus socks; protective eyewear	coveralls; chemical-resistant gloves, such as barrier laminate or butyl rubber, nitrile rubber or viton ≥ 14 mils; shoes plus socks	either	either
Kleen-Tac 85 (C8&C10 fatty alcohols) EPA Reg. No.5549-74 Coastal AgroBusiness	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

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)		Worker Notification [2]	
			Applicators and Other Handlers	To Enter Treated Area Within REI	Oral	Posted
Lannate® LV (methomyl) EPA Reg. No. 352-384 Du Pont	Danger Poison	48 hrs.	long-sleeved shirts and long-legged pants; chemical-resistant gloves; shoes plus socks; protective eyewear; exposure outdoors mist/dust filtering respirator (MSHA/NIOSH approval no. prefix TC-21C)	coveralls; chemical-resistant gloves; shoes plus socks; protective eyewear	either	either
Lannate® SP (methomyl) EPA Reg. No. 352-342 Du Pont	Danger Poison	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
Lepinox WDG (*Bacillus thuringiensis* var. *kurstaki* EG7826 lepidopteran active toxin) EPA Reg. No. 70051-89 Certis USA LLC	Warning	12 hrs	long sleeved shirt and long pants; shoes plus socks; protective eyewear	coveralls; waterproof gloves; shoes plus socks; protective eyewear	either	either
Leven-38™ (C10 fatty alcohol and maleic hydrazide) EPA Reg. No. 19713-105 Drexel Chemical Co.	Danger	24 hrs.	coveralls over short-sleeved shirt and short pants; waterproof gloves; chemical-resistant footwear plus socks; protective eyewear; chemical-resistant headgear for overhead exposure; chemical-resistant apron when cleaning equipment, mixing or loading.	coveralls over short-sleeved shirt and short pants; chemical-resistant footwear plus socks; protective eyewear, chemical-resistant headgear for overhead exposure	either	either
Lorsban® Advanced (chlorpyrifos) EPA Reg. No. 62719-591 Dow AgroSciences	Warning	24 hrs.	Coveralls over long-sleeved shirt and long pants; chemical-resistant gloves; chemical-resistant footwear plus socks	coveralls over short-sleeved shirt and short pants; chemical-resistant gloves made of any waterproof material; chemical-resistant footware plus socks; chemical-resistant headgear of overhead exposure.	yes	NR
Lorsban® 4E (chlorpyrifos) EPA Reg. No. 62719-220 Dow AgroSciences	Warning	24 hrs.	Long-sleeved shirt and long pants; chemical-resistant gloves; shoes plus socks	coveralls; chemical-resistant gloves; shoes plus socks	yes	NR

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)		Worker Notification [2]	
			Applicators and Other Handlers	To Enter Treated Area Within REI	Oral	Posted
Lorsban® 15G (chlorpyrifos) EPA Reg. No. 62719-34 Dow AgroSciences	Caution	24 hrs.	long-sleeved shirt and long pants; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	yes	NR
Lorsban® 75 WG (chlorpyrifos) EPA Reg. No. 62719-301 Dow AgroSciences	Warning	24 hrs.	Long-sleeved shirt and long pants; chemical-resistant gloves; shoes plus socks	coveralls; chemical-resistant gloves; shoes plus socks	yes	yes
Mature XL® (ethephon) EPA Reg. No. 1812-361-51873 Fair Products, Inc.	Danger	48 hrs.	coveralls over short-sleeved shirts and short pants; waterproof gloves; shoes plus socks and protective eyewear,; chemical-resistant headgear for overhead exposure; chemical-resistant apron when cleaning equipment	coveralls; waterproof gloves; shoes plus socks; protective eyewear	yes	yes
Meth-O-Gas® (100% methyl bromide) EPA Reg. No. 5785-11, -41 Great Lakes Chemical Corporation	Danger	gas con-centration less than 5 ppm	loose, long-sleeved shirts; long trousers and socks; full-face shield if SCBA not required	SCBA (self contained breathing apparatus)	NR	yes
Mocap® 10G (ethoprop) EPA Reg. No. 264-465 Bayer CropScience	Warning	48 hrs.	coveralls over short-sleeved shirt and short pants; waterproof gloves; chemical-resistant footwear plus socks; chemical-resistant headgear for overhead exposures; chemical-resistant apron when cleaning equipment, mixing and loading; dust/mist filtering respirator (MSHA/NIOSH approval number prefix TC-21C), or a NIOSH approved respirator with any N, R, P or HE filter	coveralls over short-sleeved shirt and short pants; waterproof gloves; chemical-resistant footwear plus socks; chemical-resistant headgear for overhead exposures	yes	yes
Mocap® 15G (ethoprop) EPA Reg. No. 264-457 Bayer CropScience	Danger	48 hrs.	coveralls over short-sleeved shirt and short pants; waterproof gloves; chemical-resistant footwear plus socks; chemical-resistant headgear for overhead exposures; chemical-resistant apron when cleaning equipment, mixing and loading; dust/mist filtering respirator (MSHA/NIOSH approval number prefix TC-21C), or a NIOSH approved respirator with any N, R, P or HE filter	coveralls over short-sleeved shirt and short pants; waterproof gloves; chemical-resistant footwear plus socks; chemical-resistant headgear for overhead exposures	yes	yes

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)		Worker Notification [2]	
			Applicators and Other Handlers	To Enter Treated Area Within REI	Oral	Posted
Mocap® EC (ethoprop) EPA Reg. No. 264-458 Bayer CropScience	Danger - Poison	48 hrs.	coveralls over long-sleeved shirt and long pants; chemical-resistant gloves such as barrier laminate, butyl rubber (≥14 mils), nitrile rubber (≥14 mils) or viton (≥14 mils), chemical-resistant footwear plus socks; protective eyewear; chemical-resistant headgear for overhead exposures, and chemical-resistant apron when cleaning equipment, mixing and loading, and a respirator with either an organic-vapor-removing cartridge with a prefilter approved for pesticides (MSHA/NIOSH approval number prefix TC-14G), or a NIOSH approved respirator with an organic vapor (OV) cartridge or canister with any N, R, P or HE prefilter.	coveralls over long-sleeved shirt and long pants, chemical-resistant gloves such as barrier laminate, butyl rubber (≥14 mils), nitrile rubber (≥14 mils) or viton (≥14 mils); chemical-resistant footwear plus socks; protective eyewear; chemical-resistant headgear for overhead exposures	yes	yes
M-Pede® (potassium salts of fatty acids) EPA Reg. No. 53219-6 Dow AgroSciences	Warning	12 hrs.	coveralls over short-sleeved shirt and short pants; chemical-resistant gloves such as butyl rubber, nitrile rubber, neoprene rubber or PVC, chemical-resistant footwear plus socks; protective eyewear; chemical-resistant headgear for overhead exposure; chemical-resistant apron when cleaning equipment, mixing or loading	coveralls; waterproof gloves; shoes plus socks	either	either
Nemacur 3 EC (fenamiphos) EPA Reg. No. 264-731 Bayer CropScience	Danger Poison	48 hrs.	chemical-resistant protective suit; chemical-resistant gloves, such as barrier laminate or viton, chemical-resistant footwear plus socks; protective eyewear; chemical-resistant headgear for overhead exposure; dust/mist filtering respirator (MSHA/NIOSH approval prefix TC-21C)	chemical-resistant protective suit; chemical-resistant gloves, such as barrier laminate or viton; chemical-resistant footwear plus socks; protective eyewear; chemical-resistant headgear for overhead exposure	yes	yes
Nuprid™ 2F *(imidacloprid)* EPA Reg. No. 228-484 Nufarm Americas Inc.	Caution	12 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves made of any waterproof material such as, barrier laminate, butyl rubber, nitrile rubber, natural rubber polyethylene, polyvinylchloride (PVC) or Viton; shoes plus socks	coveralls; chemical-resistant gloves made of any waterproof material such as, barrier laminate, butyl rubber, nitrile rubber, neoprene rubber, natural rubber polyethylene, polyvinylchloride (PVC) or Viton; 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)		Worker Notification [2]	
			Applicators and Other Handlers	To Enter Treated Area Within REI	Oral	Posted
Off-Shoot-T® (C6,C8,C10,C12 fatty alcohols) EPA Reg. No. 400-542 Chemtura Corporation	Danger	24 hrs.	long-sleeved shirt and long pants; shoes plus socks; and goggles or face shield.	coveralls; chemical resistant gloves made of any waterproof material; shoes plus socks; protective eyewear	either	either
Orthene® 75 S (acephate) EPA Reg. No. 59639-26 Valent USA Corporation	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
Orthene 97 (acephate) EPA Reg. No. 59639-91-5481 Amvac Chemical Corporation	Caution	24 hrs.	long-sleeved shirt and long pants; chemical resistant gloves such as Butyl rubber ≥14 mils, Nitrile rubber ≥ 14 mls or Neoprene ≥ 14 mls and socks plus shoes	coveralls; chemical resistant gloves made of any waterproof material; shoes plus socks; chemical-resistant headgear for overhead exposure	either	either
Penncozeb® 75DF (zinc ion and manganese ethylenebisdithiocarbamate) EPA Reg. No. 70506-185 United Phosphorus, Inc.	Caution	24 hrs.	coveralls over long-sleeved shirt and long pants; chemical-resistant gloves made of any waterproof material; protective eyewear when mixing or loading; chemical-resistant apron when cleaning equipment, mixing or loading; shoes plus socks;	coveralls over long-sleeved shirt and long pants; chemical-resistant gloves made of any waterproof material; shoes plus socks	either	either
Pendimax® 3.3 (pendimethalin) EPA Reg. No. 68156-6-62 Dow AgroSciences LLC	Caution	24 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves such as barrier laminate or viton; shoes plus socks	coveralls; chemical-resistant gloves such as barrier laminate or viton; 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)		Worker Notification [2]	
			Applicators and Other Handlers	To Enter Treated Area Within REI	Oral	Posted
Phaser®3EC (endosulfan) EPA Reg. No. 264-638 Bayer CropScience **NO LONGER RECOMMENDED FOR USE ON TOBACCO**	Danger	24 hrs.	Coveralls over long-sleeved shirt and long pants; chemical-resistant gloves; chemical-resistant footwear plus socks; protective eyewear; chemical-resistant headgear; a respirator with either organic vapor -removing cartridge with prefilter approved for pesticides, or a canister approved for pesticides, or a NIOSH approved respirator with an organic vapor cartridge or canister with any N, R, P, or HE prefilter. Mixers and/or loaders must wear a chemical-resistant apron in addition to all the protective equipment specified for applicators	Coveralls over long-sleeved shirt and long pants; chemical-resistant gloves; chemical-resistant footwear plus socks; protective eyewear; chemical-resistant headgear	either	either
Pic Plus Fumigant® (85.1% chloropicrin) EPA Reg. No. 87994-4 Triest Ag Group Inc.	Danger Poison	48 hrs. and gas concentration less than 0.1 ppm	Long-sleeved shirt and long pants, Chemical-resistant gloves, Chemical-resistant apron, Protective eyewear (Do NOT wear goggles), and Chemical-resistant footwear with socks, A NIOSH certified full facepiece air-purifying respirator equipped with an organic vapor, (OV, NIOSH approval prefix TC-23C) cartridge and a particulate pre-filter (Type N, R, P, or HE, NIOSH approval number prefix TC-84A), or A gas mask with a canister approved for organic vapor (NIOSH approval number prefix TC-14G).	Non-handlers prohibited	yes	yes
Platinum™ 2SC (Thiamethoxam) EPA Reg. No. 100-939 Syngenta Crop Protection	Caution	12 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)		Worker Notification [2]	
			Applicators and Other Handlers	To Enter Treated Area Within REI	Oral	Posted
Poast® (sethoxydim) EPA Reg. No. 7969-58 BASF	Warning	12 hrs.	chemical-resistant gloves (see label); coveralls over short-sleeved shirt and short pants; chemical-resistant footwear plus socks; protective eyewear; chemical-resistant headgear for overhead exposure; other: chemical-resistant apron when cleaning equipment mixing and loading	chemical-resistant gloves (see label); coveralls over short-sleeved shirt and short pants; chemical-resistant footwear plus socks; protective eyewear; chemical-resistant headgear for overhead exposure; other: chemical-resistant apron when cleaning equipment mixing and loading	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 + EC ® (flumetralin) EPA Reg. No. 100-640 Syngenta	Danger	24 hrs.	coveralls over short-sleeved shirt and short pants; chemical-resistant gloves such as barrier laminate or viton; 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 gloves such as barrier laminate or viton; chemical-resistant footwear plus socks; protective eyewear; chemical-resistant headgear for overhead exposure	either	either
Provado®1,6 F *(imidacloprid)* EPA Reg. No. 264-763 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 Corporation	Caution	24 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)		Worker Notification [2]	
			Applicators and Other Handlers	To Enter Treated Area Within REI	Oral	Posted
Prowl® H_2O (pendimethalin) EPA Reg. No. 241-418 BASF Corporation	Caution	24 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves; shoes plus socks	coveralls; chemical-resistant gloves; shoes plus socks	either	either
Quadris® (azoxystrobin) EPA Reg. No. 100-1098 Syngenta	Caution	4 hrs.	Long-sleeved shirt; long pants; chemical resistant gloves mad of any waterproof material such as polyvinyl chloride, nitrile rubber and butyl rubber; shoes plus socks.	coveralls; chemical resistant gloves mad of any waterproof material such as polyvinyl chloride, nitrile rubber and butyl rubber; shoes plus socks.	either	either
Ridomil Gold SL ® (mefenoxam) EPA Reg. No. 100-1202 Syngenta Crop Protection	Caution	48 hrs.	Long-sleeved shirt; long pants; chemical-resistant gloves made of any waterproof material such as ploye thylene or polyvinyl chloride or Viton; ; shoes plus socks	coveralls; chemical-resistant gloves made of any waterproof material such as ploye thylene or polyvinyl chloride or Viton; ; shoes plus socks	either	either
Royal MH-30® (maleic hydrazide) EPA Reg. No. 400-84 Chemtura Corporation	Caution	12 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves made of any waterproof material such as ploye thylene or polyvinyl chloride; shoes plus socks	coveralls; chemical-resistant gloves made of any waterproof material; shoes plus socks	either	either
Royal MH-30® SG (maleic hydrazide) EPA Reg. No. 400-165 Chemtura Corporation	Caution	12 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves made of any waterproof material such as ploye thylene or polyvinyl chloride; shoes plus socks	coveralls; chemical-resistant gloves made of any waterproof material; shoes plus socks	either	either
Royal MH-30® XTRA (maleic hydrazide) EPA Reg. No. 400-452 Chemtura Corporation	Caution	12 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves made of any waterproof material such as ploye thylene or polyvinyl chloride; shoes plus socks	chemical-resistant gloves made of any waterproof material such as ploye thylene or polyvinyl chloride;	either	either

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)		Worker Notification [2]	
			Applicators and Other Handlers	To Enter Treated Area Within REI	Oral	Posted
Royaltac® - M (C6,C8,C10,C12 fatty alcohols) EPA Reg. No. 400-451 Chemtura Corporation	Danger	24 hrs.	long-sleeved shirt and long pants; shoes plus socks; chemical resistant gloves; goggles or face shield	coveralls; chemical-resistant gloves made of any waterproof material; shoes plus socks; protective eyewear	either	either
Sevin® 4F (carbaryl) EPA Reg. No. 264-349 Bayer CropScience	Caution	12 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves such as barrier laminate, butyl rubber, nitrile rubber, neoprene rubber, polyvinyl chloride (PVC), or viton; shoes plus socks and chemical-resistant headgear for overhead exposure	coveralls; chemical-resistant gloves such as barrier laminate, butyl rubber, nitrile rubber, neoprene rubber, polyvinyl chloride (PVC), or viton; shoes plus socks and chemical-resistant headgear for overhead exposure	either	either
Sevin® 80S (carbaryl) EPA Reg. No. 264-316 Bayer CropScience	Warning	12 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks and chemical-resistant headgear for overhead exposure	coveralls; waterproof gloves; shoes plus socks and chemical-resistant headgear for overhead exposure	either	either
Sevin® XLR Plus (carbaryl) EPA Reg. No. 264-333 Bayer CropScience	Caution	12 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves such as barrier laminate, butyl rubber, nitrile rubber, neoprene rubber, polyvinyl chloride (PVC), or viton; shoes plus socks and chemical-resistant headgear for overhead exposure	coveralls; chemical-resistant gloves such as barrier laminate, butyl rubber, nitrile rubber, neoprene rubber, polyvinyl chloride (PVC), or viton; shoes plus socks and chemical-resistant headgear for overhead exposure	either	either
Spartan 4F (sulgentrazone) EPA Reg. No. 279-3220 FMC Corporation	Caution	12 hrs.	long-sleeved shirt and long pants; shoes plus socks; waterproof gloves	coveralls over long-sleeved shirt and long pants; waterproof gloves; shoes plus socks	either	either
Spartan Charge (sulgentrazone + carfentrazone) EPA Reg. No. 279-3337 FMC Corporation	Caution	12 hrs.	long-sleeved shirt and long pants; chemical resistant gloves made of waterproof material; 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)		Worker Notification [2]	
			Applicators and Other Handlers	To Enter Treated Area Within REI	Oral	Posted
Sucker Plucker® (C6, C8, C10, C12 fatty alcohols) EPA Reg. No. 19713-35 Drexel Chemical Co.	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; protective eyewear and chemical-resistant headgear for overhead exposure	either	either
Sucker Stuff® (maleic hydrazide) EPA Reg. No. 19713-1 Drexel Chemical Corporation	Caution	12 hrs.	long-sleeved shirt and long pants; chemical resistant gloves maede of any waterproof material such as polyethylene or polyvinyl chloride; shoes plus socks	coveralls; chemical resistant gloves made of any waterproof material; shoes plus socks	either	either
Sucker Stuff® 60 WS (maleic hydrazide) EPA Reg. No. 19713-371 Drexel Chemical Co.	Caution	12 hrs.	long-sleeved shirt and long pants; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either
Super Boll (ethephon) EPA Reg. No. 1812-361 Griffin LLC	Danger	48 hrs.	chemical-resistant gloves (see label); coveralls over short-sleeved shirt and short pants; chemical-resistant footwear plus socks; protective eyewear; chemical-resistant headgear for overhead exposure; other: chemical-resistant apron when cleaning equipment mixing and loading	chemical-resistant gloves (see label); coveralls over short-sleeved shirt and short pants; chemical-resistant footwear plus socks; protective eyewear; chemical-resistant headgear for overhead exposure; other: chemical-resistant apron when cleaning equipment mixing and loading	either	either
Super Sucker Stuff® (maleic hydrazide) EPA Reg. No. 19713-20 Drexel Chemical Co.	Caution	12 hrs.	long-sleeved shirt and long pants; shoes plus socks; chemical-resistant gloves made of any waterproof material such as polyethylene or polyvinyl chloride.	coveralls; 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)		Worker Notification [2]	
			Applicators and Other Handlers	To Enter Treated Area Within REI	Oral	Posted
Telone® C-17 (1,3-dichloropropene + chloropicrin) EPA Reg. No. 62719-32 DowAgroSciences	Danger	5 days	**Handlers performing tasks with liquid contact potential must wear:** Coveralls over short-sleeved shirt and short pants; Chemical-resistant gloves, such as barrier laminate (EVAL) or viton; Chemical-resistant footwear plus socks; Chemical-resistant headgear for overhead exposure Chemical-resistant apron; A face shield or safety glasses with brow and temple shields (do not wear chemical goggles) A half-face respirator with either an organic-vapor-removing cartridge with a prefilter approved for pesticides (MSHA/NIOSH approval number prefix TC-23C) or canister approved for pesticides (MSHA/NIOSH approval number prefix TC-14G). See further respirator requirements in the User Safety Requirements section on this label. **Handlers performing tasks with no liquid contact potential must wear:** Loose fitting or well ventilated long-sleeved shirt and long pants; Shoes and socks; A face shield or safety glasses with brow and temple shields (do not wear chemical goggles) A half-face respirator with either an organic-vapor-removing cartridge with a prefilter approved for pesticides (MSHA/NIOSH approval number prefix TC-23C) or canister approved for pesticides (MSHA/NIOSH approval number prefix TC-14G).	Loose fitting or well ventilated long-sleeved shirt and long pants; Shoes and socks; A face shield or safety glasses with brow and temple shields (do not wear chemical goggles); A half-face respirator with either an organic-vapor-removing cartridge with a prefilter approved for pesticides (MSHA/NIOSH approval number prefix TC-23C) or canister approved for pesticides (MSHA/NIOSH approval number prefix TC-14G). **REFER TO THE LABEL FOR MORE SPECIFICS ON HANDLER PPE**	yes	yes

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)		Worker Notification [2]	
			Applicators and Other Handlers	To Enter Treated Area Within REI	Oral	Posted
Telone® II (1,3-dichloropropene) EPA Reg. No. 62719-32 DowAgroSciences	Warning	5 days	**Handlers performing tasks with liquid contact potential must wear:** Coveralls over short-sleeved shirt and short pants; Chemical-resistant gloves, such as barrier laminate (EVAL) or viton; Chemical-resistant footwear plus socks; Chemical-resistant headgear for overhead exposure Chemical-resistant apron; A face shield or safety glasses with brow and temple shields (do not wear chemical goggles) A half-face respirator with either an organic-vapor-removing cartridge with a prefilter approved for pesticides (MSHA/NIOSH approval number prefix TC-23C) or canister approved for pesticides (MSHA/NIOSH approval number prefix TC-14G). See further respirator requirements in the User Safety Requirements section on this label. **Handlers performing tasks with no liquid contact potential must wear:** Loose fitting or well ventilated long-sleeved shirt and long pants; Shoes and socks; A face shield or safety glasses with brow and temple shields (do not wear chemical goggles) A half-face respirator with either an organic-vapor-removing cartridge with a prefilter approved for pesticides (MSHA/NIOSH approval number prefix TC-23C) or canister approved for pesticides (MSHA/NIOSH approval number prefix TC-14G).	Loose fitting or well ventilated long-sleeved shirt and long pants; Shoes and socks; A face shield or safety glasses with brow and temple shields (do not wear chemical goggles); A half-face respirator with either an organic-vapor-removing cartridge with a prefilter approved for pesticides (MSHA/NIOSH approval number prefix TC-23C) or canister approved for pesticides (MSHA/NIOSH approval number prefix TC-14G). **REFER TO THE LABEL FOR MORE SPECIFICS ON HANDLER PPE**	yes	yes

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)		Worker Notification [2]	
			Applicators and Other Handlers	To Enter Treated Area Within REI	Oral	Posted
Temik 15 G (aldicab) EPA Reg. No. 264-330 Bayer CropScience ***Labeled only in GA, NC, VA***	Danger - Poison	48 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	yes	yes
Ten-Tac (C-10 fatty alcohols) EPA Reg. No. 5549-79 Coastal Chemical Co.	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
Terramaster 4 EC (etridiazole) EPA Reg. No. 400-422 Crompton/Uniroyal	Danger	12 hrs.	long-sleeved shirt and long pants; chemical resistant gloves such as barrier laminate or viton: shoes plus socks; NIOSH approved respirator with an organic-vapor removing cartridge withh a prefilter approved for pesticides (MSHA/NIOSH approval number prefix TC-23C), or a a canister approved for pesticides (MSHA/NIOSH approval number prefix TC-14G) or a NIOSH approved respirator with an OV cartridge or canister with an N2, R, P or HE prefilter, chemical-resistant apron when mixing, loading or cleaning equipment.	coveralls; waterproof gloves such as barrier laminate or viton or made out of any waterproof material; shoes and socks; protective eyewear	either	either
Terramaster® 35WP (etridiazole) EPA Reg. No. 400-416 24(c) Registrant: Crompton/Uniroyal	Warning	12 hrs	long-sleeved shirt and long pants; waterproof gloves: shoes plus socks; protective eyewear; dust/mist filtering respirator (MSHA/NIOSH approved number prefix TC-21C) or a NIOSH approved respirator with any N, R, P or HI filter	coveralls; waterproof gloves; shoes and 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)		Worker Notification [2]	
			Applicators and Other Handlers	To Enter Treated Area Within REI	Oral	Posted
Terr-O-Gas® (67% methyl bromide + chloropicrin) EPA Reg. No. 5785-24 Great Lakes Chemical Corporation	Danger	48 hrs. and gas concentration less than 5 ppm (methyl bromide) and 0.1 ppm chloropic-rin	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	non-handlers prohibited	yes	yes
Thiodan® 3EC (endosulfan) EPA Reg. No. 1386-338-72693 Universal Crop Protection Alliance LLC **NO LONGER RECOMMENDED FOR USE ON TOBACCO**	Warning	48 hrs.	Coveralls over long-sleeved shirt and long pants; chemical-resistant gloves; chemical-resistant footwear plus socks; protective eyewear; chemical-resistant headgear; a respirator with either organic vapor -removing cartridge with prefilter approved for pesticides, or a canister approved for pesticides, or a NIOSH approved respirator with an organic vapor cartridge or canister with any N, R, P, or HE prefilter. Mixers and/or loaders must wear a chemical-resistant apron in addition to all the protective equipment specified for applicators	Coveralls over long-sleeved shirt and long pants; chemical-resistant gloves; chemical-resistant footwear plus socks; protective eyewear; chemical-resistant headgear	either	either
Tillam® 6E (pebulate) EPA Reg. No. 10182-158 Monterey Chemical Company	Caution	12 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves, such as barrier laminate or nitrile rubber or neoprene rubber or viton; shoes plus socks; protective eyewear	coveralls; chemical-resistant gloves, such as barrier laminate or nitrile rubber or neoprene rubber or viton; shoes plus socks; protective eyewear	either	either
Tracer™ (Spinosad) EPA Reg. No. 62719-267 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)		Worker Notification [2]	
			Applicators and Other Handlers	To Enter Treated Area Within REI	Oral	Posted
Ultra Flourish™ (mefenoxam) EPA Reg. No. 55146-73 Nufarm America's Inc.	Warning	48 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves, such as barrier laminate or viton; shoes plus socks; protective eyewear	coveralls; chemical-resistant gloves, such as barrier laminate or viton; shoes plus socks; protective eyewear	either	either
Vapam® HL (metam sodium) EPA Reg. No. 5481-468 Amvac Chemical Corp.	Danger	48 hrs.	coveralls over long-sleeved shirt and long pants; waterproof gloves; 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; a respirator with either an organic-vapor-removing cartridge with a prefilter approved for pesticides (MSHA/NIOSH approval prefix TC-23C) or canister approved for pesticides (MSHA/NIOSH approval number prefix TC-14G).	While entry is restricted only the following handling tasks may be performed in a treated area: assessing/adjusting the soil seal; assessing pest control, application technique, or application efficacy; sampling air or soil for this period. **All other tasks are prohibited until the entry restriction is over.** Handlers performing the above tasks must wear: coveralls over long-sleeved shirt and long pants; waterproof gloves; chemical-resistant footwear plus socks. **If pungent, rotten-egg odor of this product is detected, handlers must also wear:** face-sealing goggles, unless full-face respirator is worn; a respirator with either an organic-vapor-removing cartridge with a prefilter approved for pesticides (MSHA/NIOSH approval prefix TC-23C) or canister approved for pesticides (MSHA/NIOSH approval prefix TC-14G).	yes	yes

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)		Worker Notification [2]	
			Applicators and Other Handlers	To Enter Treated Area Within REI	Oral	Posted
Vydate® L (oxamyl) EPA Reg. No. 352-372 DuPont	Danger - Poison	48 hrs.	coveralls over short-sleeved shirt and short pants; chemical-resistant gloves, such as barrier laminate or butyl rubber or neoprene rubber or polyvinyl chloride (PVC) or viton or nitrile rubber; chemical-resistant footwear plus socks; protective eyewear; chemical-resistant headgear for overhead exposure; chemical-resistant apron when cleaning equipment, mixing, or loading; respirator with either an organic-vapor-removing cartridge with a prefilter approved for pesticides (MSHA/NIOSH approval number prefix TC-23C) or canister approved for pesticides (MSHA/NIOSH approval number prefix TC-14G).	coveralls over short-sleeved shirt and short pants; chemical-resistant gloves, such as barrier laminate or butyl rubber or neoprene rubber or polyvinyl chloride (PVC) or viton or nitrile rubber; chemical-resistant footwear plus socks; protective eyewear; chemical-resistant headgear for overhead exposure;	either	either
XenTari® (*Bacillus thuringiensis aizawai strain*) EPA Reg. No. 275-85 Valent Biosciences Corporation	Caution	4 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks and dust/mist filtering respirator NIOSH standards of at least N-95, R-95 or P-95	coveralls; water proof 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] Unless the pesticide labeling requires both types of notification, notify workers EITHER orally OR by posting warning signs at entrances to treated areas (both columns in the table with "EITHER"). You must inform workers which method of notification is being used. 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 ("YES" in both columns of table), 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.

U.S. Tobacco GAP Program

Grower Certification

The concept of Good Agricultural Practices (GAP) aims at ensuring sustainable, economically viable production of usable tobacco and can be defined as: agricultural practices which produce a quality crop while protecting, sustaining or enhancing the environment with regard to soil, water, air, animal and plant life as well as protecting and ensuring the rights of farm laborers.

U.S. tobacco growers are required by the purchasing companies to be certified to have attended a training conducted by members of Cooperative Extension from their land grant university. Each grower receives a Certificate of Attendance and a notebook which includes tabs labeled by the topics below. Behind each tab is information relating to the topic by sub-topics identified as i.) Good Agricultural Practices, ii.) Documentation, and iii.) Inspection List - for use in auditing the attention placed on each topic. Growers are encouraged to use the notebook and calendar for recording information on the production, handling and marketing of the crop.

I. Crop Management

a. Variety Integrity and Selection

b. Integrated Pest Management

c. Nutrient Managemet

d. Crop and Operation Management

e. Curing and Barn Management

f. Non-tobacco Related Materials (NTRM)

g. On-farm Tobacco Storage

II. Environmental Management

a. Soil and Water Management

b. Agrochemical Management

III. Labor Management

a. Laws and Regulations

b. Farm Safety and Worker Training

c. Appendix A: Resources

US Tobacco GAP Program

Barn Testing

This procedure measures the carbon dioxide (CO_2) levels inside an empty flue-cured tobacco barn to assess if combustion products are leaking from the heat exchanger into the curing chamber. Carbon dioxide is not related to the formation of tobacco specific nitrosamines (TSNAs) but is used as an indicator of a heat exchanger leak.

Barn Testing Protocol

All tobacco curing barns used to supply tobacco to a company participating in the US Tobacco GAP Program and designated as being in service must have a properly functioning heat exchanger and tested for leaks every three years. The cost and scheduling of barn testing is the responsibility of the grower.

I. All barns used by a contract grower must be tested collectively and receive a passing evaluation.

II. Barns found to have a failing heat exchanger must be repaired and retested as having a properly functioning (passing) heat exchanger.

III. Barn testing records are to be kept by the contract grower and copies provided to participating contractor purchasers according to contract requirements.

IV. Barns designated to be out-of-service (no utility connections) need not be tested.

V. Barns operating on a boiler system with a liquid to air heat exchanger (radiator) need not be tested unless a conventional fueled heat exchanger is installed and utilized as backup or supplemental heat.

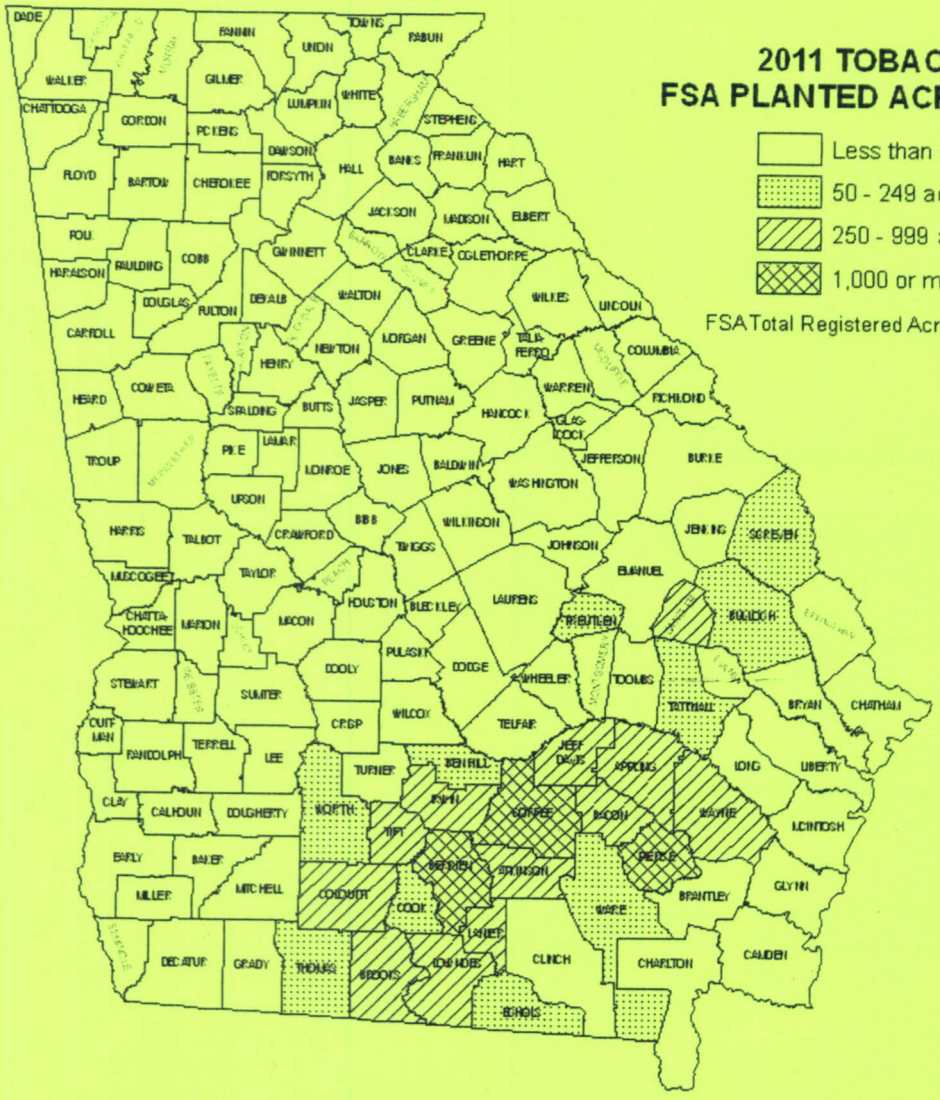
VI. Barn testing for the US Tobacco GAP Program must be performed by persons receiving training provided by an agency recognized by US Tobacco GAP. Such training is intended to ensure that barn testing is conducted in a correct and consistent manner.

VII. Training for barn testing will be provided by University Extension tobacco programs and a list of individuals receiving training will be maintained and made available to growers and the industry.

VIII. Barn testing can be conducted by independent third-party companies or individual growers who have received training identified in item #7 above.

Estimated Acres Planted in Tobacco in Georgia by County Over the Most Recent Years

County	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003
Appling	661	607	645	988	1010	1139	1278	1085	780	1071
Atkinson	417	534	914	1370	1915	1812	1543	839	474	555
Bacon	103	660	560	519	746	1043	897	768	704	922
Ben Hill	127	156	178	174	85	82	100	141	272	337
Berrein	1251	1424	1169	1475	1542	1443	1020	945	1320	1683
Brantley	32	32	30	30	31	57	127	221	336	347
Brooks	347	381	286	778	618	654	632	574	528	634
Bulloch	19		192	177	159	322	355	542	1043	1199
Candler	246	261	289	280	344	645	647	345	813	825
Clinch		24	11	74	128	138	63	66	54	72
Coffee	1406	1613	1974	2214	2391	1940	2179	1830	1666	2116
Coloquitt	342	492	624	559	707	974	992	1560	1817	2063
Cook	152	207	287	328	206	918	957	836	1048	1270
Dodge				67	75	76	60	65	91	108
Echols	193	173	102	144	110	84	110	62	146	156
Effingham	31	32	20	29	30	11		39	29	60
Emanuel	138	26		216	203	492	252	164	314	484
Evans			135	190	76	69	99	147	246	277
Grady				31	79	79	81	233	389	429
Irwin	216	252	312	521	319	317	482	394	718	980
Jeff Davis	184	436	257	125	288	129	533	432	503	891
Lanier	641	591	543	641	603	538	364	385	402	503
Lowndes	741	709	592	321	410	358	499	742	1105	1320
Pierce	982	1104	992	738	1469	1006	1109	1049	931	1228
Screven	90		99	85	94	94	100	60	55	27
Tattnall	180	168	173	299	212	474	839	959	1137	1085
Telfair		30			0			0	127	221
Thomas	44	80	166	191	142	167	197	298	499	530
Tift	278	510	456	778	796	862	756	705	889	1055
Toombs				10		50	15		630	760
Treulen		90	116	127	103	119	95	62	253	305
Ware		116	187	306	547	863	605	625	663	596
Wayne	646	707	532	909	839	1356	1118	944	482	582
Worth	144		14	142	84	120	163	242	472	527
State totals	9611	11818	11857	14840	16361	18431	18267	17359	20936	25218



Source: USDA Farm Service Agency (FSA)
http://www.fsa.usda.gov/FSA/webapp?area=newsroom&subject=landing&topic=foi-er-fri-cad

NASS 2011 Tobacco Estimates

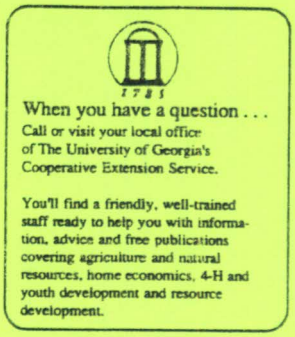
Acres Harvested: 11,900

Yield per Acre: 2,250 bu.

Total Production: 26,775,000

Source: Crop Production Report released May 10, 2012

http://usda01.library.cornell.edu/usda/current/CropProd/CropProd-05-10-2012.pdf



ATTENTION!
PESTICIDE PRECAUTIONS

1. **Observe all directions, restrictions and precautions on pesticide labels. It is dangerous, wasteful and illegal to do otherwise.**
2. **Store all pesticides in original containers with labels intact and behind locked doors. "KEEP PESTICIDES OUT OF THE REACH OF CHILDREN."**
3. **Use pesticides at correct label dosage and intervals to avoid illegal residues or injury to plants and animals.**
4. **Apply pesticides carefully to avoid drift or contamination of non-target areas.**
5. **Surplus pesticides and containers should be disposed of in accordance with label instructions so that contamination of water and other hazards will not result.**
6. **Follow directions on the pesticide label regarding restrictions as required by State or Federal Laws and Regulations.**
7. **Avoid any action that may threaten an Endangered Species or its habitat. Your county Extension agent can inform you of Endangered Species in your area, help you identify them, and through the Fish and Wildlife Service Field Office identify actions that may threaten Endangered Species or their habitat.**

Crop & Soil Sciences

CSS-06-13 **December 2012**

Issued in furtherance of Cooperative Extension works, Acts of May 8 and June 30, 1914, The University of Georgia College of Agricultural & Environmental Sciences and the U. S. Department of Agriculture cooperating.

J. Scott Angle, Dean and Director
The University of Georgia College of Agricultural and Environmental Sciences