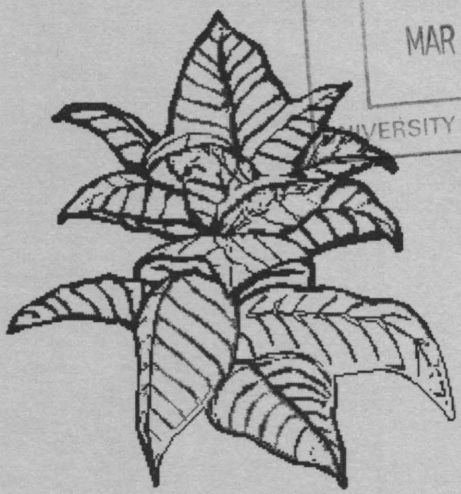
IVE
N
Tobacco
ember 1997 PUBLICATION 436-049

1998
DARK-FIRED TOBACCO PRODUCTION GUIDE



VIRGINIA COOPERATIVE EXTENSION

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

in cooperation with

Virginia Dark-Fired Tobacco Board

1998 DARK-FIRED TOBACCO

PRODUCTION GUIDE

Prepared By:

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

ACKNOWLEDGEMENTS

We are indebted to the Virginia Dark-Fired Tobacco Board for making the printing of this publication possible.

Disclaimer:
Commercial products are named in this publication for information purposes only. The Virginia Cooperative Extension Service does not endorse these products and does not intend discrimination against other products which also may be suitable.

Virginia Tech

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Virginia Cooperative Extension programs and employment are open to all, regardless of race, color, religion, sex, age, veteran status, national origin, disability, or political affiliation. An equal opportunity/affirmative action employer. Issued in furtherance of Cooperative Extension work, Virginia Polytechnic Institute and State University, Virginia State University, and the U.S. Department of Agriculture cooperating. C. Clark Jones, Director, Virginia Cooperative Extension, Virginia Tech, Blacksburg; Lorenza W. Lyons, Administrator, 1890 Extension Program, Virginia State, Petersburg.

VIRGINIA STATE UNIVERSITY

Table of Contents

AGRONOMIC INFORMATION

T. David Reed, Extension Agronomist, Tobacco

James L. Jones, Extension Agronomist, Tobacco

TRANSPLANT PRODUCTION

The production of an ample supply of uniform, healthy plants that are available reasonably early in the transplanting season is the first step for a successful crop. An outline of plant bed management practices which have proven to be effective over the years is given below. If these suggestions are followed, most of the risks in plant production should be reduced or eliminated.

1. Locate the bed on a deep, fertile soil with good surface and internal drainage and a southern or southeastern exposure. The site should be near an adequate water supply and protected by windbreaks on the north and west sides.

2. Seed 75 to 100 square yards of plant bed for each acre of tobacco to be planted. (Proper plant bed clipping may reduce needed yardage to 60 to 80 sq. yds. per acre).

3. Prepare a good seed bed. The soil should be well pulverized, smooth and free of clods. Flat and saucer-shaped beds should be avoided. To assure good surface drainage, beds should be broken to the center with a moldboard plow so that the center of the bed is 2-3 inches higher than the surrounding area. Heavy equipment that will tend to pack the soil should not be used in the later stages of plant bed preparation.

4. Fumigate soil with methyl bromide when soil moisture is right for cultivation and the air temperature is 55°F or higher, preferably in the fall. Alternatives to methyl bromide are described in the plant bed disease control section of this guide.

5. Apply 50 lbs. of 12-6-6 fertilizer per 100 sq. yds. and disc into top 2 to 3 inches of soil. If extra nitrogen is needed, 3-6 pounds of nitrate of soda (16-0-0) per 100 sq. yds. can be used as a top dressing. Organic forms of nitrogen are not suggested for use on plant beds.

6. Sow 1/6 to 1/8 oz. of seed per 100 sq. yds.; cover with a thin layer of straw and place cover directly on straw (15-20 lbs. of straw per 100 sq. yds.).

7. Suggestions for producing plants under plastic:

   a. Seed bed 60 to 65 days before anticipated transplanting date.

   b. Perforate plastic before covering seeded bed; use ¼" holes spaced 2" apart. Additional holes are needed as the weather becomes warmer later in the season.

   c. Irrigate enough to wet the soil to a depth of 6-8 inches immediately after seeding, then cover with perforated plastic.

   d. Remove cover if outside temperature reaches 85°F for two consecutive days, but replace the cover if the temperature is expected to go below 45°F.

8. Beds covered with porous materials (cotton, Reemay, etc.) should be watered frequently in dry weather. Frequent, light applications during the germination

period often mean the difference between a good stand and plant bed failure. One-fourth inch (about 140 gallons per 100 square yards) every other day should be sufficient for germination and establishment of plants. As the plants develop in size, about ½ inch of water twice a week is usually adequate. Water should be applied slowly enough so that it is absorbed and the force of the water does not dislodge seedlings. Plant beds should be watered when the soil is dry regardless of the temperature. Plants can perish in cold weather as well as warm weather.

9. Control diseases and insects using only approved chemicals.

10. Consider clipping beds two to four times about five days apart beginning at a height of four inches and ending at a height of eight inches to improve plant uniformity and/or delay growth of plants. Clip approximately ½ inch above the bud of the largest plants.

11. Consider undercutting uniform beds prior to pulling to reduce labor.

Deficiencies of sulfur or magnesium in tobacco plant beds may be corrected by broadcasting 5 lb of Epsom salts per 100 sq. yds or 3 lb/100 sq. yds of Sul-Po-Mag. Three pounds of potassium sulfate per 100 sq. yds may also be used to correct a sulfur deficiency. Apply these materials to dry plants and follow with a light irrigation.

Improved Transplant Production. Several advancements in plant bed production have been made over the last decade that serve to reduce the labor associated with plant bed culture. Information on the use of narrow raised beds, clipping, and undercutting is available from your local Extension agent and made also be found in the 1998 Flue-cured Tobacco Production Guide (VCE-Publication No. 436-048). Additional, information on float tobacco transplant production may be found in the following chapter and VCE-Publication No. 436-051, "Float Greenhouse Tobacco Transplant Production Guide" contains information specific for greenhouse tobacco production.

PREMATURE FLOWERING

Plant bed management is a key factor in reducing premature flowering. Unfavorable environments, especially low temperatures, after seedlings have five or more leaves have been shown to contribute to this problem. Plant beds sloped slightly to the south or southeast will tend to warm up more quickly in the spring, and wind breaks, such as trees, to the north and west of the beds will help to further protect the seedlings from cool weather. Plant bed covers also provide protection from cool temperatures. In an on-farm test conducted at seven locations in Virginia, removal of perforated plastic covers one week before transplanting resulted in less premature flowering compared to seedlings from plant beds whose covers were removed two weeks before transplanting. Recommendations in Virginia call for covers to be removed during the day if temperatures reach 85°F for two consecutive days, but otherwise the covers should be left on the plant beds as long as possible to help minimize chances of premature flowering. Covers should be put back on if temperatures are forecasted to drop below 45°F. More than one night of exposure to low temperatures is required to cause premature flowering, but by the time seedlings approach transplant size, one or two additional nights of exposure may be enough to push them over a critical limit and cause them to flower prematurely.

Plant bed seeding date is another management tool for controlling premature flowering. The earlier the seeding date, the greater the chances of seedlings being exposed to cool weather. Under Virginia conditions, plants grown under perforated plastic covers should not be seeded until early to mid-March.

When premature flowering occurs, the plant should be topped low enough to produce a good sucker. Care must be taken to avoid the spread of mosaic when topping and

turning out suckers. Research has shown that when less than 10 percent of the plants in a field flower prematurely, little yield is lost if nothing is done. Plowing up and replanting should be done only as a last resort, especially late in the season.

VARIETIES

Carol A. Wilkinson, Associate Professor, Agronomy

Seed of the following dark-fired (Type 21) tobacco varieties will be commercially available for 1995: VA 309, VA 312, Brown Leaf (JH), Lizard Tail Orinoco, and Shirey. Breeder seed of several other Type 21 varieties are maintained at the Southern Piedmont Agricultural Research and Extension Center, but are not commercially available at the present time.

Variety selection is a critical step in producing dark-fired tobacco with traditional flavor and aroma. Part of the "art" of curing tobacco is experience with a particular variety. Careful study of the information in Table 2 may be helpful in choosing a variety which will fit into specific management systems and alleviate or reduce the severity of particular production problems. A summary of yield, market price, and acre value of five varieties tested at the Southern Piedmont AREC in 1997 is presented in Table 1.

Table 1. Results of Dark Variety Tests Conducted at the Southern Piedmont Agricultural Research and Extension Center in 1997.

Variety	Yield Lbs/A	Value $/A	Price $/Cwt	Days to Flower	Leaf No.	Plant Ht(in.)
Brown Leaf, JH	2301	3788	164	64	12.8	23.1
Liz Tail Orinoco	2279	3663	161	67	14.1	23.6
Shirey	2454	4481	182	65	13.2	22.2
Va 309	2454	4057	165	65	13.9	24.0
Va 312	2613	4534	174	65	13.0	22.6

Table 2. General Characteristics of Dark-Fired Tobacco Varieties.

Characteristics	Brown Leaf,JH	Liz. Tail Orinoco	Va 309	Va 312
GROWTH HABIT:				
Leaf Spacing	medium	close	medium	medium
Leaf size	large	medium	medium	large
Tendency to `fire'	light	medium	medium	light
Maturity	mid-late	mid-late	mid-late	mid-late
Suckering	medium	heavy	medium	medium
DISEASE RESISTANCE:[1]				
Black Root Rot	L	S	M	H
Black Shank	S	S	M	S
Mosaic	S	S	S	R
CURED LEAF:				
Manner of curing	easy	difficult	med	easy
Predominant color	brown	brown	med-brown	red
Leaf body	med	heavy	med	thin
Size of midrib	med	med	med	med
PERFORMANCE DATA (5-YEAR AVERAGE):				
Yield, lbs/a	2245	2227	2252	2377
Value, $/A	3922	3841	3845	4237
Price, $/Cwt	174	172	170	178

[1]Disease Resistance: H=High Resistance; M=Moderate; L=Low; S=Susceptible; R=Resistant.

SOILS

Since tobacco is a high value crop and requires rather high labor input, the best soils available should be selected for producing this crop. The best tobacco is generally produced on soils such as Cecil, Lloyd, Madison, and Appling. These soils have gray to brown topsoil, dark red to reddish yellow subsoil. It is essential that tobacco be planted only on soils which have both good internal and surface drainage.

CROP ROTATIONS

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

A good 3-year rotation for dark-fired tobacco in Virginia is as follows:

First year - tobacco;
second year - small grain;
third year - red clover.

Plow-under the second crop of red clover; it will add some nitrogen and do much to improve the physical condition of your soil. Red clover is better than lespedeza in the rotation because 1) it keeps the land covered with a green crop in winter - lespedeza is dead during winter - and its green roots prevent leaching of valuable plant nutrients, 2) lespedeza in the rotation seems to increase tobacco root rots, and 3) red clover adds more organic matter and nitrogen to the soil.

If root rot is a problem on your farm, grow your tobacco on fields with a pH of approximately 5.5. Since red clover will not thrive at the pH, it is suggested that small grain and/or fescue be substituted for clover in the rotation. Fescue also helps reduce populations of certain nematodes.

An acre of topsoil 6 inches deep weighs approximately 1,000 tons. On sloping land, where no special erosion control measures are used, soil runoff can remove 10 to 25 tons of topsoil each year that tobacco is grown. At this rate, an inch of topsoil would be removed over a period of 6 to 14 years. The entire layer of topsoil would be gone in 40 to 100 years. Crop rotation reduces soil loss by decreasing soil runoff. In order to effectively reduce soil erosion, a crop rotation must alternate cultivated crops with erosion-resistant, organic matter-building crops. The individual characteristics of each field must be considered in order to develop effective crop rotation plans for erosion control. Shorter, more intense, rotations can be used on gently sloping land because such land is less subject to erosion and potential damage to soil tilth is less. Longer rotations must be used for steeply sloping and erodible land. Grasses and legumes are generally the most effective rotation crops for reducing runoff and controlling erosion.

The conservation compliance provision of the Food Security Act of 1985 also discourages production of crops in highly erodible fields where the land is not carefully protected from erosion. If crops are produced in such fields without an approved soil conservation system, producers may lose their eligibility for certain U.S.

Department of Agriculture program benefits. Contact your local Soil Conservation Service (SCS) office for more information or for soil conservation planning assistance.

FERTILIZATION

A tobacco fertilization program should supply the nutrients needed to produce a good yield of high-quality tobacco and also maintain and/or build up the nutrient level of the soil. Of the many factors that influence dark-fired tobacco production, fertilization practices are among the more important. Fertilizer requirements for dark-fired tobacco are higher than for most other agronomic crops and special attention must be given to this phase of production if the highest net profit is to be realized.

Nutrient Rates

The first step in determining fertilizer needs is a soil test. It will indicate the level of phosphorus and potassium in the soil and aid in determining if lime is needed to keep the pH in the desirable range and to supply needed calcium and magnesium. The Soil Testing Laboratory at Virginia Tech began charging a user's fee on November 1, 1990. For in-state users of the lab's services, there is a $6.00 fee for soil testing; $3.00 for organic matter and $3.00 for soluble salts. In addition to results of the soil test, the following factors should be considered in determining fertilizer rates:

1. Amount and quality of manure to be applied
2. Stand and growth of legume to be turned under
3. Cropping and fertilizer history of the field
4. Yield and quality of tobacco generally produced on the field.

Although the fertilizer program begins with a soil test, it ends with your experience. Your past results should be a major consideration when arriving at fertilizer rates.

Due to the many factors necessary to consider when making fertilizer recommendations for a particular field, data in the following table can be used only as general recommendations for phosphorus (P_2O_5) and potassium (K_2O).

Soil Test Category	Pounds suggested per acre	
	P_2O_5	K_2O
L	230*	
	60-100	150-175
M	60-100	100-150
H	40	100
VH	40	100

*Basic application; may be broadcast and plowed-in or disked-in before planting. The 230 lb P_2O_5/A can be obtained from 500 lb/A of 0-46-0.

Phosphorus is probably the nutrient used most excessively in tobacco fertilization in Virginia. Repeated applications of larger quantities of phosphorus than plants can absorb, and with essentially no loss from leaching, has resulted in a general buildup of this element. Fertilizer sales indicate that about twice as much phosphorus is generally used on tobacco as needed. Based on a summary of soil analyses of tobacco fields by the Virginia Tech Soil Testing Laboratory, approximately 88% of the soils had a medium or higher phosphorus level. Present research indicates that 40 to

60 pounds per acre of P_2O_5 is adequate for tobacco if the soil test shows phosphorus to be medium or higher.

Potassium requirements of tobacco are relatively high, and a high potassium content in dark-fired tobacco is needed for good cured leaf quality. Soils vary in their supply of available potassium, depending upon the parent material, previous fertilization, and cropping history. Approximately 100-175 pounds of potash (K_2O) per acre are adequate for most soil conditions. Potassium may be lost through leaching from the root zone in extremely sandy soil.

Since high levels of chlorine in tobacco can result in poor curing and poor leaf characteristics ("wet dog"), it is preferable to use non-chlorine sources of potash, i.e. potassium sulfate. No more than 30 pounds of chlorine per acre should be supplied to dark-fired tobacco.

Nitrogen usually affects the yield and cured leaf quality of dark-fired tobacco more than any other nutrient. Failure to apply enough nitrogen will result in small plants, early firing, and low yield and quality. Excess nitrogen can cause plants to grow too large and become difficult to harvest and cure. Present research indicates that a total of 125 to 150 pounds of nitrogen per acre are necessary to produce high yields of good quality dark-fired tobacco.

The total amount of nitrogen supplied may come from commercial fertilizer, manure, legumes, and other crop residues. Nitrogen can be lost easily by leaching from sandy soils. Therefore, sidedressing a portion of the nitrogen application and adjustments for leaching are often necessary.

After you have decided upon the amount of nitrogen, phosphorus, and potash that you should use, select from the tobacco fertilizer grades listed below the analysis that most nearly fits your needs for the preplant application. Additional N and K_2O can be applied as a sidedressing at first cultivation if needed.

Nutrients Contained In:

	1,200 lbs			1,500 lbs			1,800 lbs		
Analysis	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O
3-9-9	36	108	108	45	135	135	54	162	162
4-8-12	48	96	144	60	120	180	72	144	216
5-10-15	60	120	180	75	150	225	90	180	270
6-12-18	72	144	216	90	180	270	108	216	324
6-6-18	72	72	216	90	90	270	108	108	324

Selecting the Fertilizer Grade

The analysis of a fertilizer gives the percentage of nitrogen, phosphorus (P_2O_5), and potassium (K_2O) contained in the material. Complete fertilizer grade ratios ($N:P_2O_5:K_2O$) available for use on tobacco in Virginia are as follows: 1:3:3 (3:9:9); 1:2:3 (4:8:12, 5-10-15, 6-12-18, and 8-16-24); and 1:1:3 (6-6-18 and 8-8-24). The analysis determines the amount of nutrients supplied. For example, a 6-12-18 supplies 6 pounds of nitrogen, 12 pounds of phosphorus (P_2O_5) and 18 pounds of potassium (K_2O) for each 100 pounds. The basic difference among the three available ratios is that they supply different amounts of phosphorus relative to nitrogen and potassium. When used at comparable rates, the 1:3:3 ratio will supply more phosphorus, but since this extra phosphorus usually is not needed, there is seldom justification for using it over the 1:2:3 and 1:1:3 ratio fertilizers. The phosphorus level from the soil test should be used to determine which complete

fertilizer ratio to use. For most fields (approximately 83% in Virginia), a 1:1:3 ratio grade should be used.

Fertilizer Application

Fertilizer should be placed in the soil so that it will not be in direct contact with the roots of newly-set transplants. Fertilizer injury is frequently the cause of poor stands and irregular crops. The two general methods of applying fertilizer are broadcast and row placement. Each has a place in the fertilization of dark-fired tobacco. On the heavier soils (Cecil, Lloyd, etc.) that have been well-managed, all of the fertilizer can be broadcast and plowed-in or disked-in with good results. On the lighter textured soils (Applying) and soils of medium to low fertility, a part of the fertilizer should be placed in the row. If band placement equipment is available, place the fertilizer in two bands 8-10 inches apart and slightly deeper than the plant root crowns. Since it is difficult to set the transplants between the bands when the fertilization and transplanting operations are done separately, a combination fertilizer distributor-transplanter is recommended. If band placement equipment is not available, place the fertilizer so that it will be 3-5 inches below the root crowns.

Sidedressing

Many producers of dark-fired tobacco choose to apply all the fertilizer preplant and do not sidedress at all. This is generally acceptable on heavier textured soil where leaching losses are minimal. However, compounds present in fertilizers are relatively soluble in soil water; therefore, the salt concentration surrounding fertilizer bands may be high enough to injure plants if all the required fertilizer is applied in the row before planting. Many growers choose to apply a part of the fertilizer at planting time and the remainder as a sidedressing after planting. On lighter textured soils, this is a good practice to ensure that the fertilizer is not leached from the soil too rapidly.

Tobacco should be sidedressed early; during the first two or three weeks that it is in the field. This will ensure that sufficient nutrients are available for the crop just before it normally makes its most rapid growth (this period is generally during the second month the plants are in the field).

Research has shown that there is no advantage to sidedressing with fertilizers containing phosphorus. The most commonly used sidedressings are nitrogen fertilizers such as ammonium nitrate or fertilizers containing both nitrogen and potash (15-0-14 or 8-0-24). It is very important that nitrogen fertilizer used as a sidedressing should be based on soil fertility levels, preplant application, and past cropping history.

Liming

A liming program, based on a soil test, should be a part of the overall management program for dark-fired tobacco production. With the shift to higher analysis fertilizer grades containing less lime filler, there is a greater need to supply calcium and magnesium through a liming program. Calcium and magnesium can be obtained at a lower cost from lime than through fertilizers.

The desirable pH range for dark-fired tobacco is 5.5 to 6.0. Applying dolomitic lime when needed will lower soil acidity (raise pH) and reduce the exchangeable aluminum which can be toxic to plants. It will also increase the absorption of phosphorus and other nutrients and increase the supply of calcium and magnesium. Approximate amounts of limestone to attain a pH of 5.8 (on unlimed sandy, loamy, and clayey soils) are shown in the following table:

Approximate Amounts of Limestone to Attain a Desired pH of 5.8.

pH of Unlimed Soils	Soil Type		
	Sandy	Loamy	Clayey
	------Lime, Tons/Acre------		
5.0	1.75	2.50	3.00
5.2	1.25	2.00	2.50
5.5	0.75	1.25	1.50

Lime is never suggested for dark-fired tobacco except when a soil test indicates there is a need. Tobacco fields should not be overlimed because of the possibility of increasing certain disease problems (black root rot and black shank) and causing an imbalance of certain micronutrients.

Manganese Toxicity

In acid soils there is an increase in the availability of manganese. This element, though essential for plant growth, may be taken up in sufficient amounts to be toxic to the plants. There usually is no trouble with manganese toxicity when the acidity level is pH 5.5 or higher, but it can be expected to occur if the soil reaction drops to pH 5.0 or lower.

Under conditions of manganese toxicity, the leaves of the plants take on a light greenish yellow to a pale white, mottled appearance with dark green areas along the veins. The leaves also may appear to have a hard semi-glossy surface. If the condition is not severe the plants may seem to fully recover and return to normal appearance. Applying lime as a sidedressing cannot be expected to correct the trouble for the immediate crop.

Micronutrients

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

Boron is the micronutrient most likely to be deficient for tobacco. Generally, 0.25 pound of elemental boron per acre (approximately 2.5 pounds of borax) is sufficient to correct or prevent such deficiencies.

Animal Manure

Animal manure is a good source of plant nutrients and is a good fertilizer for dark-fired tobacco. The composition of manure varies greatly because of the care used in its storage, the type and age of animal and amount of feed. Average amounts of nutrients which can be obtained from manure are given in the following table.

Nutrients Available to Plants During the First Year Following Application of Specific Manures from Solid Handling Systems.*

Manure Source	% Dry Matter	lb/ton of manure N	P_2O_5	K_2O
Dairy cattle	20	4	3	8
Swine	18	5	6	6
Sheep	18	2	8	11
Horse	46	4	3	11
Beef cattle concrete lot	15	3	5	8
dirt lot	51	7	12	20
Turkey without litter	22	17	15	14
with litter	29	13	12	10
Poultry without litter	45	26	36	27
with litter	75	36	34	27
deep pit	76	44	48	36

*Taken from - A Handbook of Agronomy. Pub. 424-100. 1984.

To make allowances for the plant nutrient content of manure in the fertilizer program, subtract the appropriate values listed in the table from the plant nutrients suggested on the soil test report. Manure applications should not exceed 10 tons per acre because of chlorine and soluble salt levels.

Broiler Litter Experiment

An experiment was conducted at the Southern Piedmont Agricultural Research and Extension Center in 1990 to evaluate the yield, quality, and economic returns of dark-fired tobacco fertilized with broiler litter and commercial fertilizer. A summary of the results of this study is given in Table 3. A composite soil sample of the plot area was taken at three depths in May 1990 to determine fertilizer needs. The soil test results were as follows:

Depth (in)	pH	P (lbs/A)	K (lbs/A)	Ca (lbs/A)	Ma (lbs/A)	O.M. (%)	NO_3-N (ppm)
0 - l2	5.3	18	88	384	115	1.2	23
13 - 24	5.0	3	75	384	139	0.9	15
25 - 36	5.2	1	37	264	137	0.6	10

Additional commercial fertilizer (N and K_2O) was added to the broiler litter treatments to supply the same amount of total N, P_20_5, and K_20 as the all commercial fertilizer treatment (132-165-150).

As shown in Table 3, type of fertilizer (treatments 1, 4 and 5) did not affect yield, market price, or returns/acre. However, the all commercial fertilizer (Treatment 1) had a higher N concentration in the tissue than three tons/acre of broiler litter. The broiler

litter treatments (Treatments 4 and 5) had higher levels of K, Cu, and B than the all commercial fertilizer treatment. More recent research has further evaluated broiler litter as a fertilizer for dark-fired tobacco.

Table 3. Broiler Litter Test Conducted at Southern Piedmont Agricultural Research and Extension Center, 1990

Treatment[1]	Yield (lbs/A)	Price ($/cwt)	Returns ($/A)
I. All commercial fert. (132-165-150)	I870	I70	3I84
2. No fertilizer	1411	156	2200
3. 0-165-150	1305	149	1956
4. 3 tons/A broiler litter	1855	164	3051
5. 1½ tons/A broiler litter	1800	163	2929
LSD(.05)	352	11	728

[1]Clover plowed under for all plots. Additional N and K_20 applied to supply 132 and 150 lbs/A, respectively to treatments 4 and 5.
All treatments except #2 received 165 lbs/A P_20_5.

Available nutrients from the litter to the tobacco crop with immediate incorporation was calculated to be as follows: available N = 44.0 lbs/ton; available P_20_5 = 55.2 lbs/ton; available K_20 = 30.5 lbs/ton.

A follow-up experiment using broiler litter was conducted at the Southern Piedmont Agricultural Research and Extension Center and at two on-farm locations in 1992. The purpose of these tests were to determine the best method for using broiler litter as a fertilizer source for dark-fired tobacco. Yield and quality were similar for tobacco fertilized with commercial fertilizer or broiler litter. Use of broiler litter will significantly reduce the cost of fertilization. Comparisons of various fertilizer programs for dark-fired tobacco are listed in Table 4. Broiler litter may be used to supply one-half to all the required nitrogen. At these rates, sufficient P_2O_5 will be supplied and no additional phosphate will be necessary. Broiler litter will not supply recommended rates of K_2O and should be supplemented with additional potash with soils testing medium or less for K_2O.

Table 4. Cost comparisons of dark-fired tobacco fertilization programs to supply a minimum of 135 lbs/a of N, 40 lbs/A P_2O_5, and 125 lbs K_2O.[1]

Fertilizer Program	$ per acre
900 lbs of 6-12-18 plus 240 lbs of 34-0-0 or 510 lbs of 16-0-0	131 to 164
1400 lbs of 3-9-9 plus 275 lbs of 34-0-0 or 580 lbs of 16-0-0	156 to 192
1.5 tons of broiler litter[2] plus 500 lbs of 15-0-14 or 900 lbs of 8-0-24	76 to 123
3.0 tons of broiler litter plus 130 lbs of 0-0-50 or 250 lbs of 8-0-24	52 to 60

[1]Compiled by Robert L. Jones, Agr. Extension Agent in Charlotte County.
[2]Assuming a litter analysis of 40 lbs/ton of N, 77 lbs/ton of P_2O_5 and 14 lbs/ton of K_2O and cost of $15 per ton.

Test results at the Southern Piedmont Agricultural Research and Extension Center in 1992 showed no significant difference in the yield or quality of dark-fired tobacco fertilized with various commercial fertilizer programs (different complete (N-P-K) and sidedress sources).

SUCKER CONTROL

Topping

Plants should be topped at 12 to 14 leaves, depending on the vigor of the plant after the bud has formed, but before the flowers begin to open. For the plants to mature uniformly, late plants should be topped lower as the season progresses. Research has shown that extremely high topping results in no additional yield and may be detrimental to the quality of dark tobacco.

When the plants are topped, leaves continue to grow, but sucker growth accelerates as the plants attempt to reproduce and make seed. It is extremely important to keep the plants free of suckers if top yields and profits are to be realized from the crop.

Chemical Sucker Control

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

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

2. Systemic chemicals or maleic hydrazide (MH) restrict sucker growth physiologically by stopping cell division. The only growth made after MH is applied is in the expansion of cells already present in the plant.

3. The local systemic (Butralin and Prime +) stops cell division in a localized area and must wet the sucker buds in each leaf axil to be effective. Prime + has no true contact activity and does not turn the sucker black. Treated suckers will have a yellow, deformed appearance.

Suggested Topping and Sucker Control Program

Growers should strive for complete sucker control as soon as the plants reach the button stage of flowering. The following topping and sucker control programs may be followed:

Program I. Sequential Control with Contacts and Systemic (MH) Chemicals

1. Apply contact sucker control chemical (4% in 48 gal of water) when approximately 50 percent of the plants reach the button stage. If hand applied with jugs or droplines, plants should be topped before application.
2. If the crop is fairly uniform, MH may be applied as an over-the-top spray 7 days later. MH should be applied at a rate of ¾ to 1 ½ gal acre (1.5 lb MH per gal product).

Program II. Individual Plant Method with Butralin or Prime +

Apply Butrallin or Prime+ with a dropline, backpack, sprayer or jug when plants reach the elongated bud stage. Usually two or three trips are required to remove tops and treat all plants in the field. Individual plants should not be treated more than once with either Butralin or Prime +.

Growers are reminded to comply with all label directions regarding worker protection standards (WPS). Growers must pay particular attention to required personal protective equipment (PPE) and restricted entry intervals (REI) following chemical application.

Precautions with contacts:

1. Apply when suckers are small (not over one inch long).
2. Never spray foam from tank; this will burn plants.
3. Do not spray extremely succulent tobacco (tobacco with a light green to creamy white bud area). This indicates a fast rate of growth.
4. Rain within an hour after application of contacts may reduce their effectiveness.
5. Avoid weak solutions of product (see Table 5). Contact solutions should be at least 4% concentration in order to kill both primary and secondary suckers. It may be necessary to increase the concentration to 5% when applications are made under cool overcast weather conditions.

Table 5. Sucker growth of dark-fired tobacco with three concentrations of a contact solution followed by 3 qts/A of RMH-30.

Contact + Water (gals)	Contact %	Suckers per Plant	
		No.	Grams
1.5 + 49	3	5.5	151
2 + 48	4	1.1	38
3 + 47	6	0.1	0.4

Precautions with local systemics (Butralin or Prime +):

1. Rain occurring within 2 hours after spraying may reduce effectiveness.
2. Applications to leaning plants, wet plants, or wilted plants may reduce effectiveness.
3. Applications made before the elongated button stage of growth may result in chemical topping or distortion of leaves that were too immature at time of application.
4. If suckers are not contacted by the material, they will grow vigorously and become very large.
5. Prime + carryover residues may injure small grain and corn, and has been reported to stunt early season growth of tobacco when used with dinitroaniline herbicides such as Prowl. A number of precautions have been added to the Prime + label to apprise growers and applicators of the potential carryover and subsequent stunting of rotational crops that can occur if Prime + is applied excessively. Fall disking and deep tillage are suggested to minimize this potential.

Precautions with systemics:

1. Do not apply during the hot part of the day when stomata are closed and leaves are wilted.

2. Rain within six hours after application of MH may reduce its effectiveness. If any rain occurs more than three hours after application, only a half rate of MH should be reapplied to maintain good sucker control.

1997 Sucker Control Test

Results of a sucker control test conducted on dark-fired tobacco at the Southern Piedmont Agricultural Research and Extension Center in 1997 are presented in Table 6. Treatment 1, topped-not-suckered, was included to evaluate the control of the other treatments. Treatments 2 and 3 are considered to be standard treatments among dark-fired tobacco producers. Plants were topped in the button to elongated button stage and dropline treatments were only once to individual plants. Only two trips were made through the field to top plants and approximately 90 percent were topped on the first date. Application codes in Table 6 are DI = dropline application and OVT = over-the-top application as a coarse spray. All of the treatments, except 11 and 12, provided excellent sucker control Little difference was observed between 2 and 2.5% Butralin (T5 and T6, respectively). The application of a contact fatty alcohol (OffShoot-T) prior to Butralin in T7 and T8 or the application of MH following Butralin (T9 and T10) did not significantly improve sucker control. Treatments 11 and 12 did not provide adequate sucker control with an over-the-top application of Butralin. Adequate sucker control is difficult to obtain with over-the-top foliar sprays where MH is not used. Local systemics such as Butralin and Prime + most contact each leaf axil to provide control. This is particularly difficult with crocked or leaning plants.

Table 6. Summary of results of dark-fired tobacco sucker control test at the Southern Piedmont Agricultural Research and Extension Center, Blackstone, Virginia, 1997.

Treatment No.	at topping	1 week later	Application Code* 1	2	Yield lbs/A	Percentage sucker control	Plants free of any sucker (%)
1	topped-not-suckered	---	---	---	1212	---	0.0
2	Prime 2 +	---	DL	---	2438	100.0	97.5
3	Off-Shoot-T 4%	RMH 1.5 gal/A	DL	OVT	2363	99.5	92.5
4	Off-Shoot-T 4%	RMH 1.0 gal/A	DL	OVT	2316	99.0	82.5
5	Butralin 2%	---	DL	---	2462	97.2	97.5
6	Butralin 2.5%	---	DL	---	2372	100.0	100.0
7	Off-Shoot-T 4%	Butralin 2%	DL	DL	2385	97.0	82.5
8	Off-Shoot-T 4%	Butralin 2 ½ %	DL	DL	2377	100.0	97.5
9	Butralin 2%	RMH 1.0 gal/A	DL	OVT	2502	100.0	100.0
10	Butralin 2%	RMH 3 qt/A	DL	OVT	2346	100.0	97.5
11	Off-Shoot-T 4%	Butralin 1 gal/A	DL	OVT	2203	77.8	57.5
12	Off-Shoot-T 4%	Butralin 3 qt/A	DL	OVT	2315	74.9	42.5

* DL= dropline application and OVT = over-the-top application with three spray nozzles.

Suggestions for Application of Sucker Control Materials

Type of Product	When to Apply	Time of Day	Application Rate	Application Procedure
Contacts (fatty alcohols)	1. 1st appl. at 50% button 2. Later applications should be made 1 week apart (if needed)	When plants are turgid and leaves dry (mid-morning to mid-afternoon)	4% solution or 2 gal in 48 gal of water and apply at 50 gal of spray material per acre. (5% = 2.5 gal in 47.5 gal of water) (6% = 3 gal in 47 gal of water)	Hand Application 20 psi max. and ½ to 2/3 fl oz per plant Power Spray 20 psi using 3 solid cone nozzles per row (i.e. TG-5 and 2 TG-3's)
Local systemics (Butralin and Prime +)	1. Individual plants at elongated button stage (droplines or jug application) 2. 7-10 days after contact application	When leaves are dry	2 to 2 ½ % solution of Butralin or 2 % of Prime+ (2% = 1 gal in 49 gal of water or 2 ½ oz in 1 gal.) (2 ½ = 1 ½ gal in 48 ½ gal of water or 3.2 oz in gal.	Hand Application Individual plant application with dropline or jug, apply ½ fl oz per plant. Power Spray 20 psi using 3 solid cone nozzles per row (i.e. TG-5 and 2 TG-3's)
Systemics (MH) or (Maleic hydrazide)	When used as part of sequential control program - apply 7 after contact application.	In morning, after leaf surfaces are dry. Do not apply during the middle of hot days when may be plants wilted.	1 1/8 to 2 ¼ lb of MH (¾ to 1 ½ gal of 1.5 lb/gal product) Apply 40 to 50 gal of spray material per acre.	Apply as a fine spray using 3 hollow nozzles per row (TX-18) and 40 to 60 psi or as a coarse spray using 3 solid cone nozzles (2 TG-3 and 1 TG-5) and 20 psi.

TRANSPLANT PRODUCTION IN OUTDOOR FLOAT BEDS

T. David Reed, Extension Agronomist, Tobacco

A successful tobacco crop begins with an ample supply of disease-free, high quality transplants. Although modern plant bed production techniques have help reduce the labor necessary for transplant production, the use of greenhouse technology provides the greatest labor savings and convenience. Float greenhouse transplant production significantly reduces the labor required to pull plants for transplanting, provides some measure of control over environmental conditions, and generally results in greater transplant uniformity. Crops planted with greenhouse-grown transplants typically grow-off in the field with greater uniformity thus allowing for easier management.

Greenhouse transplants production requires an increased capital investment as compared to traditional plant beds. Greenhouse culture is an entirely new plant production system for tobacco growers and new problems and pests may arise from many sources. Finally, pest control options are limited while the potential severity of plant loss is much greater than with an outdoor plant bed. Disease control is largely dependent upon grower management and chance.

The acreage of the typical dark-fired tobacco grower in Virginia is too small to justify the investment in conventional greenhouse for transplant production. Consequently, many such growers have started purchasing transplants from transplant growers, thus taking advantage of the convenience of greenhouse transplants without the investment of a greenhouse. Although it is generally recommended to grow your own transplants, purchasing transplants from a reputable local source is the best alternative to importing transplants from out-of-state. Importation of transplants provides a means of introduction of diseases that may not otherwise be present in your local community. The most serious threat is from Blue Mold. Although no guarantee, transplants imported into Virginia should be certified "disease-free" at their place of origin.

Outdoor float beds offer the small acreage tobacco producer a viable means of utilizing float greenhouse techniques without the capital investment of a greenhouse. The outdoor float bed should be managed as a "mini-greenhouse" although growers should realize that management is more difficult and less convenient in the outdoor float bed. In the float system, seedlings are grown in Styrofoam trays floating in shallow pools of water. The water is contained within a frame constructed of 2 x 6 or similar lumber and fertilizer is supplied from the float water.

Float Production Systems

The float system may be used to grow tobacco transplants using one of three different production methods:

1. direct-seeded – trays are seeded with pelleted seed and germinated and grown to transplant size in the outdoor float bed
2. plug-and-transfer – "miniplugs" or small seedlings are purchased from a greenhouse grower and transferred by hand to float trays where they are grown to transplant size in the outdoor float bed
3. seed-and-transfer – similar to plug-and-transfer except small seedlings are started in germination trays that are seeded and placed in a warm location within your home

Of the three production systems described above, the majority of growers would be best served by the direct-seeded method. Although requiring the most heating

capacity and special seeding equipment, direct-seeding requires the least amount of labor. Plug-and-transfer is not a viable option due to the lack of miniplugs for Virginia dark-fired tobacco. The remainder of this production guide will focus primarily on the direct-seeded system, but a suggested production program for seed-and-transfer is described at the end of this chapter. Additional information on specific greenhouse management practices is available from local agricultural Extension agent and VCE Publication no. 436-051 "Float Greenhouse Tobacco Transplant Production Guide."

Float Bed Construction

There are many possible designs for outdoor float beds. Although the cost of construction and the use of readily available materials should be considered, there are other factors of greater importance. The design and construction of a float bed must be sufficient to withstand weather conditions (wind, rain, and snow) that can be expected to occur. The design should maximize ease of management (ie. ventilation and daily observation). The float bed described in this publication has been evaluated with burley tobacco at the Southwest Virginia and flue-cured and dark-fired tobacco at the Southern Piedmont Agricultural Research and Extension Center since 1993. This float bed is a relatively narrow design and utilized a removable frame for the top. Positive attributes of this type of design include:

- ease of access for checking of seedlings
- excellent ventilation
- the ability to provide sufficient heat for uniform germination
- the possibility for mechanized clipping of seedlings

Calculating Float Bed Space

The size and number of float beds required will depend on the number of transplants needed, an expected percentage of useable transplants, and the cell number of the trays to be used.

Transplants needed = no. of acres x plants per acre

22,750 transplants = 3.5 acres x 6500 plants per acre

seedlings needed = transplants x 100 / % useable

28,437 seedlings = 22,750 transplants x (100/80%)

Trays necessary to produce 28,000 seedlings:

Float cell number	Percentage of useable transplants		
	70	80	90
200	163	143	127
242	135	118	105
253	128	113	100
288	113	99	88

The percentage of useable transplants that a grower obtains is dependent upon a number of factors that may or may not be entirely controllable . However, management practices such as tray filling, heating, clipping, and disease control have a direct impact.

Determining the size of the float bed frame:

A float tray is approximately 13.5 in. wide and 26.5 in. long. The float bed should be sized to hold the desired number of trays and have approximately 2 in. of free space inside the frame. The additional space will allow for removal of trays from the bed; however, an excessive amount of open water space will encourage algae growth. Trays can be turned in either direction with respect to the length of the float bed. In the following example, trays are turned with the long side running with the length of the bed.

The width of the bed would be:

width = no. of trays x 13.5 + 2 in.

and the length:

length = no. of trays x 26.5 in. + 2 in.

Example: One float bed to hold 100 trays which would plant approximately 3.5 acres of tobacco (assuming 80% useable plants).

width = 5 trays x 13.5 + 2 in. = 5 ft. 10 in.

length = 20 trays x 26.5 in. + 2 in. = 44 ft. 4 in.

A length of 44 ft. would probably be too long for light weight construction and would be more difficult to manage. Two beds half this length would be the easiest to build and manage. Growers should consider the heating capacity, structural strength of the bed (particularity the top), and the ease of management of large float beds.

The length of the bed can be made from 1 or more lengths of 2 x 6 treated lumber and joined securely. Short wooden stalks driven into the ground along the length of the bed will keep the frame from bowing under the weight of the water contained inside. The cover over the float bed may be constructed in one of many different ways. Factors to consider include:

- The top must have adequate strength to support any accumulation of rain or snow. Strength is dependent on construction materials used and spacing of the bows over the float bay.
- The height of the top over the trays should be sufficient to shed water. However, if too great, heating will be made more difficult.
- A top that can be easily removed and replaced will improve management. A completely removable top will allow for better observation of plants, ease of clipping, and allow for better ventilation.

The bed frame should be lined with a single layer of 6 mil black plastic to hold water in the float bay. The ground under the plastic should be smoothed and may be covered with a thin layer of sand or rock dust to reduce the likelihood of sharp objects puncturing the plastic liner. Any leaks that do occur should be repaired. Float beds should be located on a site receiving full sun and near electricity, if necessary. The site should be leveled to provide uniform depth of water throughout the float bays. Sand or rock dust may be used for leveling and will reduce drainage problems and muddy areas around the bays.

Heating of Outdoor Float Beds

Supplemental heat will be necessary for reliable production of transplants in outdoor float beds. Transfer beds may require limited heating for frost protection. Heat lamps (60 to 100 watt light bulbs) strung above the plants for the length of the float bay (100 watts per 100 sq. ft.) or water bed heaters should provide adequate frost protection. Direct-seeded beds require more extensive heating to obtain satisfactory germination. The low cost, temporary nature of outdoor float beds limits the available options for heating. Research conducted at the University of Tennessee and the Southern Piedmont AREC have evaluated the use of electric water bed heaters and ceramic heaters for direct-seeded float beds. Growers are reminded that ceramic heaters have a high electrical demand which limits the number that can be used. Each ceramic heater requires a separate 20 amp circuit with a ground fault interrupt. **Growers must exercise extreme caution and follow all safety rules pertaining to electrical wiring and the use of electrical equipment in the outdoor environment and near water.**

The use of water bed heater mats is the safest and most reliable means of effectively heating an outdoor float bed. Water bed heaters are available from furniture stores that sell water beds. The mat should not be placed directly in the water but placed under the bag liner plastic. Controls and electrical connections must be kept dry.

In order for a water bed neater to provide sufficient heat, areas of open water must be provided to allow heat to pass from the water to the air above the trays. This is best accomplished by leaving 2 or 3 trays empty and placing them upside down in the bay. A guideline on the number of water bed heaters needed is 1 heater per 25 trays. Equally as important as heating the outdoor float bed is preventing heat loss. This is best accomplished by covering the beds at night with solid black plastic. Beds should be covered at night when temperatures are expected to fall below 40^0F. The use of water bed heaters with open spaces in the bed and covering the beds at night is the best, low cost means of heating a direct-seeded float bed. Less heat or even no heat will work in some years but the results are entirely dependent on the weather.

Covers for Outdoor Float Beds

Clear, solid plastic should not be used as a cover material for an outdoor float bed. High temperatures can buildup very rapidly under solid plastic and result in death of young seedlings. The typical outdoor float bed does not have sufficient ventilation to prevent the buildup of excessive heat under clear sky and full sun conditions, unless a means of ensuring adequate ventilation is provided. Fabric plant bed covers, such as Reemay and Typar, are better suited for float beds. Although not essential, two layers of Reemay or a heavier weight cotton cover may be used to further insulate the beds during cold weather. This is particularly important during seed germination. Vispore, a plant bed cover material made by Tredegar Industries, is a perforated plastic cover that has been evaluated on outdoor float beds at the Southern Piedmont AREC. The very small holes in this material reduce the buildup of excessive heat and shed water instead of allowing rainfall to pass through onto the plants. It is recommended that the heavier grade (2.5 mil) of this cover be used for float beds and the cover should be turned with the rough side up.

Checklist for Float Bed Management

1. Sanitation
2. Ventilation and Temperature Control
3. Water Quality
4. Fertilization
5. Tray Filling and Seeding
6. Clipping

Sanitation is the primary means of preventing the development of diseases in the production of greenhouse tobacco transplants. The introduction of soil-borne diseases may be prevented by not allowing the movement of field soil into the float bed. The area surrounding the float beds should be covered with sand, rock dust, or gravel to prevent muddy areas and reduce the likelihood of soil contaminating plants. Trays taken to the field should be washed free of soil after transplanting to prevent the introduction of disease organisms in the greenhouse in the following season.

Float tray sanitation is of utmost importance in reducing the likelihood of introduction and spread of disease organisms within the greenhouse. Sanitation should begin for the next crop as the first crop is transplanted in the field. At the end of the day, or soon thereafter, trays should be washed to remove media, algae, and any field soil. The best option currently available to most growers is to fumigate with methyl bromide.

Directions for the use of methyl bromide fumigation are as follows:

- Wash trays to remove surface debris.
- Arrange trays in loose stacks no higher than 5 ft. tall.
- Enclose the stacks in plastic (including the underside) and seal air tight with tape.
- Release 3 lbs. Of methyl bromide per 1000 cu. ft. of enclosed space (approximately 1500 trays) and allow to set 24 to 48 hours.
- Carefully aerate trays before removing for use or placing into storage.

Methyl bromide is a restricted use pesticide and must be used by a licensed pesticide applicator. Read and follow all label precautions.

An alternative to fumigation is the use of a dip solution. Trays may be dipped in either a chlorine bleach solution or a commercial greenhouse disinfectant product. Directions for disinfectant tray dips are as follows:

- Dip trays in a 10 percent solution of chlorine bleach (1 gal. of bleach to 9 gal. of water).
- Rinse trays in fresh water after dipping to remove excess residues than can be toxic to young tobacco seedlings under certain conditions.
- If a commercial greenhouse sanitizing product is used, follow all label directions for proper dilution and use of the product. These products generally kill on contact with the pathogens. Rinsing of trays before seeding is a good practice to reduce the possibility of residues that may affect seedling growth. Bleach solutions kill pathogens on contact. Therefore, allowing the material to remain on trays does not increase the level of control and may actually injure young tobacco seedlings.

Research conducted in recent years has demonstrated that such dips are of limited effectiveness with the Styrofoam trays used in float greenhouse production. As trays are used from one season to the next, they become more porous and thus more difficult to effectively sanitize. Furthermore, injury due to excessive residues is also more likely to occur with each additional season of use.

Proper sanitation with the clipping of seedlings is important to prevent the spread or introduction of disease within the greenhouse. Clipping is a very effective means of spreading tobacco mosaic virus (TMV); and therefore, the mower must be thoroughly cleaned to prevent spread of the virus throughout the entire greenhouse. Secondly, clippings that fall from the mower can serve as a food source for pathogens that may later infect tobacco seedlings.

Steps in clipping sanitation:

- Remove all plant debris from the underside of the mower deck using soapy water. Either a brush or a high pressure washer may be used to clean the mower deck.
- The mower should be disinfected with a 50 percent bleach solution (1 gal. of bleach to 1 gal. of water) or other commercial greenhouse disinfectant product (follow label directions).
- Cleaning the mower is easiest and most effective immediately after clipping rather than before the next clipping.
- Use only a mower with a bagging attachment and empty the bag frequently to ensure clean removal of clippings.
- If clumps of clippings fall onto plants - periodically stop to remove excess debris from the underside of the mower deck.

Ventilation and temperature control are essential to providing environmental conditions that are favorable for transplant production.

The following guidelines should be followed for heating of float beds:

Growth Stage	Time Period	Minimum Temp.	Maximum Temp.
germination	first 2 weeks	72°F	95°F
after maximum emergence	usually after first 2 weeks	50 to 55°F	95 to 110°F

Float tobacco seedlings from greenhouses and float beds appear to be more sensitive to the development of cold injury symptoms than plant bed seedlings and certain varieties appear to be more susceptible than others. However, cold injury observed with float transplants the past few years has not appeared to permanently harm the seedlings or affect growth of the transplants.

High temperatures resulting in injury or death of seedlings is actually a more serious cold temperatures. Reduced growth may occur with temperatures above 95°F and death of seedlings may occur at 110°F. High temperatures are more critical with younger seedlings (especially 2 to 4-leaf seedlings) and temperatures greater than 95°F should be especially avoided during the early development of the plants. The buildup of lethal high temperatures may occur very rapidly under a solid plastic cover on a float bed.

Water quality is of critical importance in greenhouse transplant production. Over the last four years in Virginia, there has been a limited number of water quality problems requiring corrective measures. However, the sporadic occurrence of water problems in southside Virginia makes water quality problems difficult to predict and thus a water analysis (for plant culture) should be done to identify any potential problems. Contact your local Extension agent for more information regarding water quality and water testing.

Surface water sources such as ponds and streams should be avoided for float bed production. Soil-borne pathogens may wash from tobacco fields to these sources and be introduced into the float bed water.

Fertilization of float tobacco transplants requires knowledge of the water chemistry, fertilizer analysis, and an accurate estimate of water contained in the bays or applied overhead.

Fertilizers used with float tobacco production must be completely water soluble and intended for use with growing media that contains no field soil. Most of these fertilizers will supply all necessary nutrients, including micronutrients, to tobacco seedlings growing in soilless media mixes.

Fertilizers for soilless greenhouse mixes (potting media) are available in a range of analyses for N:P:K. Those used for float tobacco should have at least half, preferably 60 to 70 percent, of the nitrogen in the nitrate form. Nitrogen from such fertilizers will be more available to the plants and will generally have the most appropriate acid/base reaction in the water. Fertilizers containing urea or large amounts of ammonium should not be used for float tobacco production.

Greenhouse fertilizer rates are customarily expressed as "parts per million" (ppm) rather than pounds per acre Parts per million may be defined as the quantity of a substance contained in a million parts of a solution. For example, a 100 ppm N solution contains 100 oz of N per million ounces of water. Information to calculate the volume of water bays and the amount of fertilizer to produce a solution of a specific concentration are presented later in this section.

Numerous fertilization schedules can be used for float tobacco transplant production and all should successfully produce transplants. The following schedule requires only two fertilizer additions and has been found to be effective.

Suggested Fertilization Program for Float Tobacco Transplants

1. At seeding to 1 week after seeding, add
    - 150 ppm of nitrogen (N)

***Example**: fill a 16 x 5.5 ft float bed with approximately 220 gal. of water and dissolve 22 oz. of 20-10-20.*

If algae growth on media and trays has previously been a problem or concern, add fertilizer 7 to 10 days after seeding of trays. Otherwise, add fertilizer to the water at seeding.

2. Approximately 4 weeks after seeding, refill float bed to the initial water level and add an additional
    - 100 ppm of nitrogen

***Example**: add 15 oz. of 20-10-20 to a 16 x 5.5 ft float bed and refill with water to a depth of 4 inches.*

Even mixing of fertilizer in the float bed water is necessary for uniform growth of seedlings. Adequate mixing is more difficult when fertilizer is added after trays are

seeded. Sump pumps may be used to distribute fertilizer evenly throughout large float beds.

3. Most soilless media intended for use with greenhouse tobacco transplant production should contain adequate sulfur (S). If deficiency symptoms occur, sufficient sulfur can be readily supplied with the addition of:
   - 4 oz of Epsom salts per 100 gal of water

Seedlings suffering from sulfur deficiency appear pale yellow, slow growing, and may have a mottled look.

Micronutrient fertilizers are generally not needed for greenhouse transplant production. The range between deficient and toxic levels of micronutrients is often very narrow; and therefore, caution is necessary with their use. If deficiency symptoms appear, contact your local Extension agent for micronutrient sources and rates.

Calculation of Water Volume and Fertilizer Concentration

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

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

Example: $16 \text{ ft} \times 5.5 \text{ ft} \times \frac{4 \text{ in}}{12} \times 7.48 = 217 \text{ gal}$

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

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

Example: $\frac{150 \text{ ppm N}}{20\% \text{ N}} \times 1.33 = 10 \text{ oz per } 100 \text{ gal}$

Table 1. Amount of selected fertilizer grades to produce fertilizer solutions with 50 to 200 ppm nitrogen.

Fertilizer analysis	ounces of fertilizer per 100 gals of water at various nitrogen (N) concentrations (ppm)					
	50	75	100	125	150	200
20-10-20	3.3	5.0	6.7	8.3	10.0	13.3
16-4-16	4.2	6.2	8.3	10.4	12.5	16.6
15-5-15	4.3	6.7	8.9	11.1	13.3	17.7

Proper tray filling and seeding are essential to produce a high percentage of usable plants. The media used for float transplant production is a specially formulated material and can not be satisfactory substituted with common potting media used with house plants. Greenhouse tobacco mixes should be available from most farm supply dealers. When filling trays, media should have sufficient moisture to properly pack into the cells. If the media needs additional moisture, water should be added to the bags the day before trays are to be filled.

Most growers using outdoor float beds will not have automatic tray filling equipment available. When filling trays by hand, distribute the potting mix in a systematic manner to fill all cells with the same amount of mix. Dry cells occur when media does not fill the entire cell and thus fails to wick properly. Seed in dry cells do not germinate and thus a potential transplant is lost. A second problem related to tray filling is the occurrence of spiral root plants. This condition occurs when the root of a germinating seed does not penetrate into the media. Such plants will eventually die and thus a potential transplant is lost. The cause of spiral root plants is not completely understood; however, it does appear to be related to inadequate media aeration (too little air/too much water). Media must not be packed too tightly into trays or excessively moistened. If float trays are watered over-the-top to help dissolve seed coatings, water should be applied as a fine mist. Large droplets can result in excessive packing and waterlogging of the media.

Clipping of the seedlings will be necessary to improve uniformity and increase stem diameter of the transplants. Clipping should be considered essential in a direct-seeded bed since germination may occur over a period of several days, thus creating initial lack of uniformity. This is greatly reduced in transfer float beds.

Proper clipping is perhaps the management practice that is most difficult in an outdoor float bed as compared to a conventional greenhouse. The crudest method is to remove the trays from the bed and clip with a high clearance lawn mower on the ground or mounted on a table. Labor can be reduced by constructing a frame to support the clipping mower over the floats in the bed or by clipping with a bush hog (tractor and bush-hog must straddle the bed and the site around the beds must be level with the float beds). Clipping should begin when plants reach 2 to 2 ½ inches to the bud and clip to within 1 to 1 ½ inch of the bud leaves. The more uneven the plants stand, the earlier clipping should begin.

Plants should be clipped every 3 to 5 days. Proper sanitation is critical to prevent the introduction and spread of disease into float beds. Equipment used to clip plants must be kept clean, remove all plant debris, and sanitize with a 50 percent chlorine bleach solution (1 gal of bleach to 1 gal. of water).

Suggested Sizes of Outdoor Float Beds

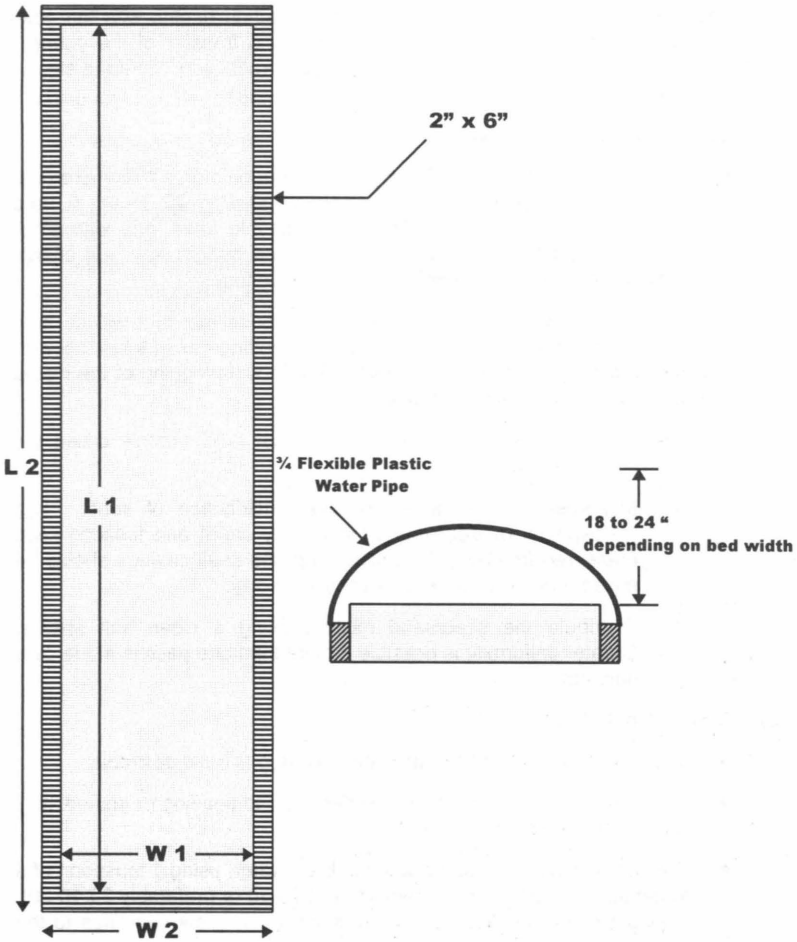
The following are suggested dimensions for the style of float beds evaluated at the Southern Piedmont AREC. These beds consisted of a 2x6 frame for the water bed and a 2x4 frame (turned up on the 2 in. side) around the water bed to attach cover support bows made from ¾ in. flexible water pipe. The 2x4 cover frame can be completely removed from the float bed to provide ventilation and allow for clipping.

Tray Number			Inside Dimension			
			2 x 6 in. bed frame		2 x 4 in. frame for cover	
Width	Length	Total	L_1	W_1	L_2	W_2
3	6	18	13' 5"	3' 7"	13' 10"	4' 6"
3	8	24	17' 10"	3' 7"	18' 3"	4' 6"
3	10	30	22' 3"	3' 7"	22' 8"	4' 6"
4	6	24	13' 5"	4' 8"	13' 10"	5' 1"
4	8	32	7' 10"	4' 8"	18' 3"	5' 1"
4	10	40	22' 3"	4' 8"	22' 8"	5' 1"
5	6	30	13' 5"	5' 10"	13' 10"	6' 3"
5	8	40	7' 10"	5' 10"	18' 3"	6' 3"
5	10	50	22' 3"	5' 10"	22' 8"	6' 3"
6[a]	10	60	22' 3"	6" 11"	22' 8"	7 ' 4"
6[a]	14	84	31' 1"	6" 11"	31' 6"	7 ' 4"
6[a]	18	108	39' 11"	6" 11"	40' 4"	7 ' 4"
6[a]	22	132	48' 9"	6" 11"	49' 2"	7 ' 4"

[a]The size of a removable top constructed with a 2 x 4 frame may be too large with float beds wider than 8 feet or longer than 15 or 20 ft.

Bows supporting the cover can be made from ½ or ¾ in. flexible water pipe. Space bows 18 to 24 in. apart. The length of the bows should be 90 in. for a float bed 4 trays wide and approximately 104 in. for a bed 5 trays wide.

Constructing float beds wider than 6 trays or longer than 15 or 20 feet will make a removable top difficult to lift. In this case, other provisions must be made to provide adequate ventilation and access to the float trays.


2" x 6"
L 2
L 1
¾ Flexible Plastic
Water Pipe
18 to 24 "
depending on bed width
W 1
W 2

Procedures for Seed-and-Transfer Transplant Production

Transplant production with the seed-and-transfer method begins with the sowing of uncoated seed in small pans or trays and later hand transfer of the young, bare-rooted seedlings to float trays used for greenhouse production. Specific steps in the seed-and-transfer procedure include:

1) Seeding of germination trays

- Plastic nursery flats available from most garden stores make excellent germination trays. The most common size is 22 x 11 in. and approximately 2 in. deep. The use of double trays, one with small holes in the bottom and placed into a solid bottom tray, will enable watering of the germination trays from the bottom.
- Fill germination trays with soilless greenhouse mix that will be later used for the float trays. Do not pack the potting mix in trays, allow to settle into place. Overpacking will result in waterlogging of the media and cause poor seedling growth.
- Germination trays may be seeded by what is commonly called the "salt shaker" method:
  - -- Mix seed with a carrier for even distribution of seed. Two tablespoons of clean sand (white play sand) and tobacco seed measured from two .22 caliber long rifle shell casings should be mixed thoroughly for each germination tray.
  - -- Distribute the seed/sand mixture using a clean salt shaker. Greater uniformity is possible if more than one pass is made over each tray.

2) Fertilization and watering

- Watering from the bottom rather than overtop is most desirable.
- The potting mix may be initially wetted prior to seeding or immediately after trays are seeded.
- The initial wetting should be with fertilized water, using 1 teaspoon of a water soluble 20% nitrogen fertilizer (20-20-20 or preferably 20-10-20). This amount of fertilizer should be sufficient to grow seedlings to the transfer size.
- Check trays daily for watering; keep approximately ½ in. of water in the bottom tray.

3) Growing environment

- Germination trays may be placed in a heated (70°F) area of a house receiving indirect sunlight throughout the day. More attention is necessary if placed in direct sunlight. High temperatures that can kill young seedlings may occur if trays are covered with plastic and placed in full sun.
- If fluorescent lights are used, place close together and directly above the trays (12 to 18 in.). Provide at least 14 to 16 hours of light each day (continuous light is acceptable). Trays placed under artificial lights may be initially covered with clear plastic to provide increased humidity for the first 3 to 4 days. Seedlings grown under artificial lighting will require hardening-off. Trays should be moved to outside shade for 2 to 3 days for hardening before transfer of seedlings to outdoor float beds.

- Trays may also be placed in a heated greenhouse or heated cold frames. Special attention is necessary to provide adequate ventilation to prevent excessively high temperatures in small, heated, enclosed environments receiving direct sunlight.

4) Timing and number of germination trays

- Seedlings will be ready for transfer 3 to 4 weeks after seeding (1 to 1 ½ in. tall).
- Each tray should produce 1200 to 1500 seedlings.
- Allow an additional 4 to 5 weeks after transfer for seedlings to grow to transplant size in the outdoor float bed.

DARK-FIRED TOBACCO DISEASE CONTROL

Charles S. Johnson, Extension Plant Pathologist, Tobacco

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

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

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

Table 1. Suggested Rotation Crops for Tobacco Disease Control

Disease	Suggested Rotation Crop
BLACK SHANK	Any alternate crop may be used
GRANVILLE WILT	Soybeans, Fescue, Small Grains, and Lespodeza 'Rowan' are most effective; Corn can also be used. Cotton and Milo are least effective.
TOBACCO CYST NEMATODE	Small Grains, Fescue, Corn, Sorghum
ROOT-KNOT NEMATODE	Small Grains, Fescue, Sudan Grass
TOBACCO MOSAIC	Most crops other than tomato and pepper
BLACK ROOT ROT	Small Grains, Fescue, Corn, Most non-leguminous plants.

EARLY DESTRUCTION OF ROOTS reduces overwintering populations of nematodes and disease-causing organisms, as well as many insects, grasses, and weeds. This practice destroys the tobacco debris that pathogens rely on for food and shelter during the fall and winter. The earlier and more complete the destruction of tobacco debris, the better the disease control. Always remember that the objective of early root destruction is to pull the roots out of the ground, dry them out, break them up, and get them decayed as soon as possible. Table 2 lists the steps involved in this important tobacco disease control practice:

Table 2. Steps in Early Root Destruction

1. Plow or disc-out stubble as soon after harvest as possible. Be sure to pull roots completely out of the soil.
2. Re-disc the field 2 weeks after the first operation.
3. Plant a cover crop when root systems are completely dried-out and dead.

DISEASE-RESISTANT VARIETIES are available for black root rot (VA 312, VA 309), black shank (VA 309, VA 310, VA 331) and mosaic (VA 312). Producers with severe disease problems should seriously consider using these varieties. However, resistant varieties are not immune to disease. Significant losses can still occur under heavy disease pressure. Crop rotation and early root destruction should be used along with resistance. Pesticide use may also be necessary in fields with a history of extremely severe black shank or black root rot.

DISEASE CONTROL IN TOBACCO GREENHOUSES

Tobacco growers have very few options for disease control in tobacco greenhouses. Many greenhouse disease problems have been related to excessive or sloppy watering, poor drainage, poor ventilation, or injured or overcrowded seedlings. ***Dithane DF is the only disease control chemical labeled for use in tobacco greenhouses***. Greenhouse operators must, therefore, make every effort to keep disease-causing organisms out of the greenhouse and to maintain an environment within the greenhouse that minimizes the chance of disease spread.

Sanitize Trays and Keep Underlying Surfaces Clean:

Float trays should be cleaned, and then fumigated with methyl bromide or aerated steam (140^0 F to 175^0F for 30 minutes), to minimize damping-off and sore shin caused by *Rhizoctonia.* Dry trays should be loosely packed no more than 5 ft high and completely enclosed and sealed in plastic. Three pounds of methyl bromide will fumigate 1,000 cubic feet (approximately 1,500 trays). Trays should be fumigated for 24 to 48 hours, then aerated for at least 48 hours before use. Be sure to read the label for space fumigation and follow it exactly. Float trays should be dipped in a solution of bleach or disinfectant, in addition to fumigation, when tobacco mosaic occurred in the greenhouse during the previous year. Trays should be allowed to dry, and then rinsed, before use. Be sure to read the label for any disinfectant used and follow it exactly.

Disease causing organisms can enter a greenhouse in soil or plant debris. Entrances and walkways should be covered with asphalt, concrete, gravel, or rock dust. Float bay liners should be clean and free of soil and plant debris. Greenhouse equipment should be sanitized, as well as footwear, before entering a greenhouse. A 1:10 solution of household bleach and water is sufficient for these purposes, as are most disinfectants.

Be Sure that Water and Media are Pathogen Free:

Do not use water from surface water sources like streams or ponds because these sources may be contaminated by soil run-off from fields infested with black shank or Granville wilt. Also, be careful to avoid introducing any disinfectants into water intended for plant uptake.

Keep Clipping Equipment Clean; Dump Clippings Frequently and Far Away:

Improper clipping practices can increase problems with collar rot and mosaic. Blades and mower decks should be sanitized before and after each clipping with a 1:1 bleach: water solution. Clipped tissue should also be collected frequently and removed from the greenhouse immediately. Clippings, unused plants, and media should be dumped as far away from the greenhouse as possible. Tobacco products should never be brought into a greenhouse used for transplant production. Hands should always be washed with soap before working with plants or with anything that will come into contact with plants.

Manage Moisture in the Greenhouse:

Transplant foliage should be kept as dry as possible for as long as possible. Maintaining air temperatures inside the greenhouse close to outside temperatures will

help minimize condensation. Ventilating and assuring good air circulation within the greenhouse will also help control humidity. Keep vents open except when frost or cold injury threaten to reduce leaf wetness. Leave greenhouse vents open an inch or so when heating a greenhouse. Keeping the vents open allows the moist, warm, air inside the greenhouse to exit as colder, drier, air comes in. Vents can be closed after 15 to 30 minutes of heating. Overhead watering should be minimized and should be set up to minimize splashing media from one cell to another. Poor drainage conditions should be corrected to avoid damping-off, as well as to prevent any contribution to humidity inside the house.

Blue Mold Control:

Blue Mold control has become a critical issue for tobacco producers. Weekly applications of ½ lb of Dithane DF per 100 gal of water (1 level tsp/gal) should begin approximately 1 week after seedlings have covered the media within tray cells. Spray volumes should increase from 3 to 6 gal/1,000 sq. ft. as plants develop. Fungicide application should continue until plants are transplanted. This spray schedule will help minimize damage from target spot and sore shin, as well as blue mold. *Growers are **strongly** recommended to keep their greenhouses free of tobacco from October through February* to reduce the chances of carrying the blue mold fungus over from one growing season to the next.

Keep the Greenhouse Clean All Year Long!

As a general rule, plants closely related to tobacco (tomatoes, peppers, etc.) should not be grown in greenhouses used for transplant production. If the greenhouse is not being used in the summer, closing it up may help prevent future disease problems. Temperatures at or above 140°F for 8 hours/day for 7 consecutive days can effectively control some weeds, insects, fungi, and some bacteria. Make sure that you place a thermometer inside the greenhouse to ensure that temperatures in the house remain high enough, long enough. Don't forget to remove any heat-sensitive materials from the greenhouse before closing it up.

SPECIFIC DISEASES IMPORTANT IN VIRGINIA

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

Black root rot decays roots of infected plants and causes plants to grow poorly early in the growing season. Plants may appear to recover as the season progresses and temperatures increase. Black root rot may be controlled by keeping soil pH between 5 and 6, planting a resistant variety (VA 312 or VA 309), avoiding early planting into cold soils (65°F), promoting good soil drainage, and using a 3-year rotation with small grains or corn. Red clover, soybeans, or other legumes should not be planted in black root rot infested fields.

BLACKSHANK MANAGEMENT SYSTEMS FOR DARK-FIRED TOBACCO [1]

Resistance[2]	One-Year Rotation	Continuous Tobacco
VA 309	Ridomil 1+0+½ or Ridomil 1+0+0 **plus:** Telone C-17, 7 gal or Chloro-O-Pic 100, 3 gal	Ridomil 1+0+½ or Ridomil 1+½+½ or Ridomil 1+0+1 or Ridomil 1+0+0 **plus:** Telone C-17, 7 gal or Chloro-O-Pic 100, 3 gal
Any other variety	Ridomil 1+0+½ or Ridomil 1+½+½ or Ridomil 1+1+1 or Ridomil 1+0+0+ **plus:** Telone C-17, 7 gal or Chloro -O-Pic 100, 3gal	Ridomil 1+0+½ or Ridomil 1+½+½ or Ridomil 1+1+1 or Ridomil 1+0+0 * **plus:** Telone C-17, 7 gal or Chloro-O-Pic 100,3 gal **Add 1 pt at layby where disease has been severe.*

[1] Modified from Table 9-5, *Flue Cured Tobacco Information 1998*, T. A. Melton, North Carolina Cooperative Extension Service, North Carolina State University.

[2] See Table 2 in the Agronomic section.

[3] If root knot nematodes are present, a nematicide with a rating of "Good" or better should be used. An appropriate fumigant treatment will be necessary if Granville wilt or tobacco cyst nematodes are also present in the field. Ridomil rates are lb for Ridomil Gold WSP and pt for Ridomil Gold EC. Rates are listed in the following order of application: Broadcast, preplant + 1st cultivation + layby.

While any rotation crop should help reduce levels of the black shank pathogen, the bacterium that causes Granville wilt can also cause disease on irish potatoes, peanuts, pepper, tomatoes, and eggplant. The Granville wilt pathogen can also multiply on roots of some common weeds, such as ragweed.

Tobacco Mosaic virus can be spread from manufactured tobacco products, old tobacco sheets, undecayed tobacco roots and stalks left over from previous crops, and from weed hosts such as horsenettle and ground cherry. Tobacco mosaic cannot be eliminated without crop rotation and early root destruction or use of a mosaic-resistant variety (VA 312). Significant losses in tobacco yield and quality can be prevented by avoiding use of tobacco products in greenhouses, plant beds, and fields. During the planting season, wash hands every half-hour with a 1% detergent solution. Old boxes and tobacco sheets should also be washed before use to store transplants. After transplanting, remove any plants showing symptoms of mosaic.

Blue mold, brown spot, frogeye, target leaf spot, and ragged leaf spot can be significant problems for Virginia tobacco producers. Obtaining transplants locally will reduce the chances of introducing blue mold from tobacco production areas outside Virginia. Ensuring that greenhouses are free of tobacco during the winter will also help prevent survival of the blue mold fungus between the 1997 and 1998 growing seasons. Preventative methods also involve Ridomil as a broadcast, preplant treatment and/or weekly application of Dithane or Acrobat MZ. Ridomil will not control some strains of the blue mold fungus. However, satisfactory control of blue mold is generally more difficult to achieve with foliar fungicides. In addition, Acrobat MZ may not be available in 1998. No fungicides are currently registered for control of the

other leaf spots of tobacco. Avoiding any production practice that contributes to "thin", physically damaged leaves will help reduce the severity of disease.

Tobacco Cyst (TCN), Root-Knot, and Lesion Nematodes are microscopic worms that live in the soil and feed on tobacco roots. Plant beds should be fumigated to ensure that transplants are nematode-free. Nematodes can be introduced into "clean" fields via plants, soil or water. Avoid using transplants from TCN-infested farms or using transplant or irrigation water from ponds or streams that drain from infested fields. Be sure that equipment used on TCN-infested land (including custom applicators) is thoroughly cleaned before using it on uninfested land.

Significant nematode problems are usually found in fields continuously planted with tobacco. Selection of rotation crops is very important. Crops such as tomato, pepper, and eggplant are susceptible to all of the major tobacco nematodes. Soybeans are as susceptible to root-knot and lesion nematodes as tobacco. Poor control of nematodes and soil insects can increase problems with black shank.

The following table presents generally appropriate practices to control different levels of root-knot nematodes:

INTERPRETING ROOT-KNOT INFESTATION LEVELS

Risk of Crop Loss	% Roots Galled	Nematodes/500 cc of soil: Fall Sample	Nematodes/500 cc of soil: Spring Sample	Control Options
Very Low	1 to 10	1 to 200	1 to 20	Practice crop rotation.
Low	11 to 25	201 to 1,000	21 to 100	Use crop rotation with a nematicide.
Moderate	26 to 50	1,0001 to 3,000	101 to 300	Increase rotation interval, and use a nematicide rated 'G' or higher.
High	Over 50	Over 3,000	Over 300	Further lengthen rotation interval if at all possible. Use a nematicide rated 'E'.

APPLICATION METHODS

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

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

Foliar Spray - A disc-core type of cone nozzle (D3-45, etc.) or hollow-cone nozzle (TX-10,12, or 18) should be used to apply foliar sprays to dark-fired tobacco. Fungicides should be applied at 40-100 psi in 20 to 100 gallons of water per acre. Spray volume should increase as plants increase in size in order to get adequate coverage. Both the tops and bottoms of leaves need to be covered. The use of drop nozzles for field sprays will also help increase coverage. Plant Bed and greenhouse applications should not begin until plants are at least the size of a dime. Applications should be repeated at 5-7 day intervals.

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

Band-Row (B-Row) - Refer to nematicide table for instructions for application of granular formulations of pesticides.

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

PLANT BED FUMIGANTS

Disease	Chemical	Product	Rate/100 sq yds	Remarks
Nematodes and diseases	dazomet (99%)	Basamid Granular	7.5 lbs	Fall application is strongly encouraged. Prepare seedbed as you would for seedling. Soil temperatures **must** be above 43°F. Spread uniformly using a shaker, Gandy, or similar-type applicator. Avoid leaving untreated spots or edges. Incorporate to a depth of 8 inches and cover with plastic immediately. Be sure to thoroughly seal the edges of the cover along the margins of the bed. Remove plant bed covers 5-7 days after treatment and aerate according to the label. A germination test should be conducted before seeding to ensure that no gas residues remain. Waiting periods between treatment and seeding should be 11-47 days, depending upon soil temperature, structure, and moisture.
	methyl bromide (98%) + chloropicrin (2%)	Brom-0-Gas (cans)	9.0-18.0 lbs	Fall fumigation is preferred. Prepare seedbed as you would for seeding. You must use an air-tight cover. Treat at soil temperature above 55°F. Expose soil to chemical for at least 24 hours and then aerate 24 to 48 hours before seeding. The hot-gas method will permit shorter exposure time. METHYL BROMIDE IS EXTREMELY POISONOUS. Use higher rates for disease and nematode infestations. Read precautionary statements.
		Terr-0-Gas 98 (cylinders)		
	methyl bromide (69%)	MBC	9.0 lbs	
	methyl bromide (66%) + chloropicrin (33%)	Terr-0-Gas 67	13.5 lbs	
		Tri-Con 67/33	9.3 lbs	

PLANT BED FUMIGANTS

Disease	Chemical	Product	Rate/100 sq yds	Remarks
Nematodes, insects, weeds, damping-off, black shank (Cont'd)	metham (32%) (SMDC)	Vapam	1.5 gal	Fall fumigation is preferred. Prepare seedbed as you would for seeding. Apply to freshly prepared moist soil when temperature is above 55° F. Tarp Method: Inject chemical to a depth of 5 inches or spray or drench in 40.0 gal of water per 100 sq yds. Apply uniformly over the entire area. Cover area immediately with plastic no less than 1 day, but no more than 2 days. After removing plastic, cultivate soil lightly and wait 21 days prior to planting in treated area. Read precautionary statements.
	metham (42%) (SMDC)	Sectagon 42	1.25 gal	

FOLIAR DISEASES OF TOBACCO SEEDLINGS

Disease	Chemical and Formulations Active Ingredient	Rate	Remarks
Tobacco Mosaic Virus (TMV)	Milk (whole or skim)	5 gals/100 sq yds of bed	Spray plants in plant bed from 1 to 24 hours before pulling. Should be combined with washing hands with phosphate detergent.
	Milk (dry skim)	5 .0 lbs in 5.0 gals water /100 sq yds	
	Phosphate detergent	¼ cup /gal of water	Wash hands every 15 minutes during transplanting operations.
Anthracnose *(Colletotrichum gloeosporoides)* Blue Mold *(Peronospora tabacina)* Target Spot *(Thanatephorus cucumeris)*	Dithane DF 0.5 lb/100 gal (1 level tsp/gal)	Foliar Spray	Apply as a fine spray to the point of run-off to ensure thorough coverage. For best results, begin applications before disease has been observed, but not before seedlings are the size of a dime. Start applications immediately after transferring plugs in the plug-and-transfer system. Use 3 gal of spray mixture /1000 sq. ft. (or 100 sq. yd.) when plants are about the size of a dime. Use 6-12 gal /1000 sq. ft. (or 100 sq. yd.) when the canopy has closed and plants are close to ready for transplanting. Repeat applications on a 7 day interval to protect new growth
	Carbamate WDG (4 tbsps/3gal)	Foliar Spray	For blue mold control in plant beds (only).
Angular Leaf Spot or Wildfire *(Psendomonas)*	Agrimycin 17, Agri-strap, etc. 100-200 ppm (2-4 tsp/3gal)	Foliar Spray	

FIELD DISEASES OF TOBACCO

Root and Stem Diseases

Product	Rate/A	Application Method[1]	Disease[2]		
			Black Shank	Black Root Rot	Granville Wilt
Ridomil Gold EC	1-2 pt	PPI	G	---	---
Ridomil Gold WSP	1-2 lb	PPI	G	---	---
Ridomil Gold EC	1 pt + 0.5 - 1.0 pt + 0.5 - 1.0pt	PPI + Early	VG	---	---
Ridomil Gold WSP	1 lb + 0.5 - 1.0 lb + 0.5 - 1.0 lb	PPI + Early	VG	---	---
Telone C 17	10.5 gals	F-Row	F	F	G
Chlor-O-Pic	3 gals	F-Row	F	F	G
Chloropicrin 100	3 gals	F-Row	F	F	G
Tri-Con 67/33	6 gals	F-Row	F	F	G
Terr-O-Gas 67	6 gals	F-Row	F	F	G

[1]PPI - preplant incorporated; F-Row - inject 8 inches deep in row with single shank in center of row. PPI + Early - for improve control of black shank, additional Ridomil may be applied to the shoulders of tobacco beds at the first cultivation and again just before the last cultivation. Drop nozzles should be used to apply Ridomil after transplanting. Do not use more than a total of 6 qts of Ridomil 2E, 3 pt of Ridomil Gold EC, or 3 lb of Ridomil Gold WSP per acre.

[2]Control rating - F=fair; G=good; VG=very good. (X) - Will reduce disease losses but no current information on disease control performance. (-) - No disease control or not labeled for this disease.

Foliar Diseases - Blue Mold

Chemical	Material	Rate[1]	Application Method[2]	Comments
Systemic Fungicide				
metalaxyl	Ridomil Gold EC	0.5-1 pt + 0.5 pt/A	PPI + Layby	Ridomil applied PPI may control blue mold early in the season, as well as *Pythium* damping-off. For prolonged control of blue mold, apply additional Ridomil to row middles just before the last cultivation. Read precautionary and rotation crop restrictions.
	Ridomil Gold WSP	0.5-1 lb + 0.5 lb/A	PPI + Layby	
Protectant Fungicide				
Mancozeb	Dithane DF	1.5 - 2.0 lbs per 100 gal of water	FS	Use only when Ridomil-insensitive blue mold is predicated. Spray weekly for complete coverage until blue mold no longer threatens. Apply 20 to 30 gal/A of spray solution during the first month after transplanting. Gradually increase spray volume as the crop grows. Spray volumes should range between 80 and 100 gal/A on tobacco ready to be topped. Don't spray within 21 days of harvest.

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

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

FIELD DISEASES OF TOBACCO

Nematodes[1]

Product	Rate/A, Application Method[2]	Nematodes: Root-Knot and Others	Nematodes: Tobacco Cyst
Fumigants			
Chlor-O-Pic Chloropicrin 100	3- 4 gal, Row	E	G
Telone II	9-10 gal, Row	E	G
Telone C-17	10.5 gal, Row	E	G
Terr-O-Gas 67	6-8 gal, Row	E	G
Tri-Con 67/33	6-8 gal, Row	E	G
Granular or Liquid Non-Fumigants			
Furadan 4F	1.5 gal, PPI	P	---
Lorsban 4E	1.25 gal	P	---
Mocap 6EC	1-2 gal, Band or PPI	P	---
Mocap Gel	1-2 paks/4000 ft, Band or 3-6 paks/A, PPI	P	---
Mocap Plus 4-2EC	1.5 gal, Band; 1.5-2 gal, PPI	P	---
Nemacur 3SC[3]	½-1 gal, Band	G	---
Nemacur 3SC[3]	½-1 gal, Band following fumigation with Chlor-O-Pic	E	G
Nemacur 3SC[3]	1-2 gal, tank mixed with a soil insecticide	G	---
Nemacur 3SC[3]	1.3-2 gal, alone, PPI	G	F
Vydate L	1.25-2 pt, TPW, or 1 gal, PPI	P	---

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

[2] PPI=Applied broadcast, preplant incorporated; Row=inject 8 inches deep in row with single shank - 21-day waiting period before planting; Bcast=Inject 10-12 inches deep through chisels set 8 inches apart; TPW=transplant water (use at least 2000 gal of water/A); Band=spray or apply granules in a 14-inch band, then incorporate. Granules should be covered with 2-6 inches of soil when forming beds.

[3] Use maximum rates to control tobacco cyst nematodes. Tank-mixes should include at least 1.3 gal/A of Nemacur if root-knot populations in fall samples are higher than 3000 per 500 cm^3 of soil or if significant galling has been seen on roots of resistant varieties. Alternate use of Nemacur with other nematicieds.

FIELD DISEASES OF TOBACCO (Cont'd)

There Are No Field Chemical Controls For the Following Diseases

Disease	Comments
Botrytis Blight (*Botrytis cinerea*)	This disease is restricted to tobacco greenhouses. A wet rot is often first observed on stems or leaves. A gray, downy material may be present on the surface of diseased areas. The only control methods available involve reducing surface moisture on leaves and stems (by correct watering and improving ventilation) and by collection and removal of loose leaf material resulting from transplant clipping operations.
Brown Spot (*Alternaria alternata*)	Can be severe on mature tobacco, especially during periods of high humidity. To help reduce losses, use a resistant variety. Avoid practices that would leave mature leaves in the field or delay the maturity of the tobacco. Good sucker control also helps reduce disease incidence.
Collar Rot (*Sclerotinia sclerotiorum*)	Symptoms of this disease (occurring only in greenhouse and float bed systems) resemble damping-off. Small groups of plants have brown, wet lesions near the base of stems. Leaf rot may be seen that appears to progress from leaf margins or tips toward the stem. White, cottony, mold may be visible. Irregularly shaped, white to black objects (scierotia) may also be found attached to severely infected plant parts. Infected plants, as well as plants immediately adjacent to diseased areas, should be discarded as soon as possible. Improving ventilation and reducing excess moisture may help reduce spread of the causal organism. Proper clipping procedures may also help.
Frenching (nonpathogenic causal agent)	This disorder has been associated with toxins produced by a nonpathogenic bacterium, *Bacillus cereus*, and other nonpathogenic microorganisms. Frenching is more prevalent on wet, poorly-aerated soils. This problem can be more severe on neutral or alkaline soils and is sometimes associated with lack of available nitrogen or other minerals. Proper drainage and fertilization can be beneficial. Do not plant in alkaline soils and avoid heavy applications of lime.
Frog Eye (*Cercospora nicotianae*)	Avoid over fertilization with nitrogen. Use a 2-year rotation and be sure to plow refuse under early. The green spot stage can be avoided by starting the curing process at 38°C (100°F) with 100% relative humidity.

FIELD DISEASES OF TOBACCO (Cont'd)

There Are No Field Chemical Controls For the Following Diseases

Disease	Comments
Ragged leaf spot (*Ascochyta nicotianae*)	Can be severe on green as well as mature tobacco. This disease may appear anytime during the mid-to latter part of the growing season. Severe epidemics will only occur when fields, and especially the leaves, remain wet for prolonged periods of time. No fungicides or resistant varieties are available. Harvesting mature tobacco promptly and minimizing crop stress are the best controls known at this time.
Sore Shin and Damping-Off (*Rhizoctonia solani*)	These diseases are primarily a problem on young plants. Proper sanitation, watering and ventilation improves disease control. Fumigants can be used in plant beds at rates for control of fungi. Use only disease-free transplants to control sore shin. Cool, wet weather after transplanting favors disease in the field. No field control practices or resistant varieties are available.
Southern Stem and Root Rot (*Sclerotium rolfsii*)	This disease can start in float beds, greenhouses, or plant beds, so fumigating plant beds and using only disease-free transplants is essential for satisfactory control. No effective field control practices or resistant varieties available.
Target Leaf Spot (*Thanatephorus cucumeris*)	Can occur in greenhouses, plant beds, and in the field. Can be severe on green, as well as mature tobacco. Severe epidemics only occur when leaves remain wet for prolonged periods of time. No resistant cultivars are available. Improving watering and ventilation of transplants, harvesting mature tobacco promptly and minimizing crop stress are the best controls known at this time.
Viruses (mosaic, vein-banding, tomato spotted wilt,	Once a plant is infected, it remains infected for life. Resistant varieties are available for tobacco mosaic.
Weather Fleck (ozone)	This disorder appears as small brown to tan leaf spots in the plant bed and field. The major cause of this problem is ozone from car, industrial and natural sources. Hot humid days followed by heavy rains increase severity of problem.
Wildfire, Angular Leaf Spot (*Pseudomonas tabaci* and *P. angulata*, respectively)	Resistant varieties and early harvesting are necessary to prevent complete loss. Rotation is recommended. Streptomycin sulfate is used in the plant bed to obtain bacteria-free transplants. In addition, streptomycin sulfate can be used in the field.

WEED CONTROL IN DARK-FIRED TOBACCO

Charles S. Johnson, Extension Plant Pathologist, Tobacco

Weed control is an important part of producing a quality tobacco crop. Good weed control uses crop rotation, early root and stalk destruction, cultivation, and appropriate use of herbicides. Application of a herbicide before transplanting (PPI) or over-the-top at transplanting (OT) will reduce reliance on the first cultivation for early season weed control. The number of cultivations can often be reduced when a herbicide has been applied PPI or at transplanting. Some herbicides may also be applied to the row middle just after the last cultivation to obtain full season weed control. Herbicide use should be based upon the specific weeds present in each field, the weed control program that integrates best with overall farm management practices, herbicide cost in relation to performance and crop safety, and anticipated rotational crops. Herbicide performance and safety are dependent upon the use of correct application methods. Special effort should be made to apply all herbicides exactly as stated on the product label.

IMPORTANT CONSIDERATIONS IN HERBICIDE USE

Selecting the Proper Herbicide

Weed Identification - Identifying the problem weeds in each field should be the first step in any weed control program. The majority of herbicides used in tobacco will control grasses and a limited number of broadleaf weeds. Check herbicide labels to ensure that the products are active against the desired weeds.

Use of herbicides with rotation crops may reduce populations of hard-to-control weeds in tobacco fields and avoid some of the problems associated with use of tobacco herbicides. The table on page 48 is a relative summary of herbicide performance for the majority of weeds found in dark-fired tobacco fields in Virginia.

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

Proper Herbicide Application

Soil Preparation - The herbicides used in tobacco fields control weeds by preventing seed germination. Already established weeds are not significantly affected. All weed growth and crop stubble should be thoroughly worked into the soil prior to application of a tobacco herbicide. Soil should be moist and loose, with all clods broken up, before a herbicide is applied.

Spray Equipment - A standard low-pressure (25 to 50 psi) boom sprayer should be used to apply herbicides with liquid or wettable powder formulations. Use in 20 to 40 gallons of water per acre. Check for clogged nozzles and screens frequently while spraying. Use 50-mesh screens in strainers, nozzles, and suction units. Clean or replace dirty or worn out sprayer, boom, and nozzle parts to ensure uniform application. Be sure to calibrate the sprayer before use to avoid crop injury and/or poor herbicide performance due to improper spray gallonage or a non-uniform spray pattern. Ensure that the spray solution is continuously agitated. Do not apply a herbicide in strong wind, since wind can cause uneven coverage. Poast must be applied at higher pressures (40 - 60 psi) using smaller spray volumes (5 to 20 gallons

of water per acre). Use only hollow cone or flat-fan nozzles to apply Poast. Never leave a spray mixture in a sprayer overnight!

Herbicide Incorporation - Herbicides should generally be incorporated as soon after application as possible. Avoid using a large field disc to incorporate PPI herbicides. Use a field cultivar or a combination, tandem, double disc, or disc harrow set to cut 4 to 6 inches deep. A disc set to cut 4 to 6 inches will incorporate a herbicide in the top 1 to 2 inches of soil. Shallow incorporation with implements set to cut less than 2 inches deep can result in erratic weed control. A disc operated only one time does not incorporate a herbicide adequately. Incorporating equipment should be operated in two different directions, at right angles to each other, at 4 to 6 mph. Discs should be no more than 24 inches in diameter and 8 inches apart. P.T.O.-driven equipment (tillers, cultivators, hoes) perform best on coarse soil types. P.T.O.-driven equipment should be set to cut 3 to 4 inches deep and should not be operated at a speed greater than 4 mph. Tillage is often required with OT herbicide use. Irrigation is also often required to incorporate tobacco herbicides applied at layby. Using incorporation equipment and/or tractor speeds not listed on the product label may result in poor or erratic weed control and/or crop injury.

Undesired Effects of Herbicide Use

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

Effects of Herbicides on Rotation Crops - Residues from some tobacco herbicides may reduce growth of crops following tobacco. These effects are discussed in the labels for the particular herbicides involved. Potential carry-over can be reduced by: 1) using the minimum labeled rates for the chemical, for your weed problems, on your soils; 2) applying herbicides at transplanting and/or layby rather than before transplanting; 3) fall tillage for early root destruction; and, 4) by deep plowing before seeding the small grain crop.

Plant Bed Herbicides

Adequate weed control in dark-fired tobacco plant beds can usually be obtained by fumigating the beds. Devrinol 10G is the only product available to control white clover in tobacco plant beds. However, Devrinol can also injure tobacco plants if used at excessive rates. Poast is now available for use on tobacco plant beds to control germinated grasses. Special care is needed when mixing Poast. First fill the sprayer with ½ to ⅔ of the water needed to make the application with continuous agitation, add the oil concentrate, then Poast and then the remaining volume of water. Don't apply Poast: (1) at rates above 0.33 oz. (2 tsp)/100 sq. yd. of plant bed; (2) more than once per season; (3) to transplanted tobacco; (4) to grasses under stress; (5) if rainfall is expected within 1 hour; (6) with any other pesticide, additive, or fertilizer except as specified on the Poast label; or (7) through any type of irrigation system.

Over-the-Top After Transplanting (OT) and Layby Herbicides

An OT application can be made as either a band or broadcast application within 7 days of transplanting. Tillage is required immediately before or at the time of an OT application, if the OT application is made more than 2 days after transplanting, or if rain has fallen or irrigation was applied since the crop was transplanted.

1. Band Application - Apply the herbicide in a 14 to 24 inch band over the top of transplants during transplanting. Use fan-type, even-spray nozzles (8004E, etc.) on the spray equipment attached to the transplanter. The amount of herbicide

required per acre of crop is reduced with band application and can be determined by the following formula:

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

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

Apply layby herbicides as directed sprays to the row middles immediately after the last normal cultivation. Use drop nozzles equipped with flat, flood-jet (TK2, TK4, etc.) or even, flat-fan (8004, etc.) nozzles to apply the herbicide solution in a 16 to 30 inch band in the row middles. Use nozzles which apply one-half (½) the normal number of gallons per acre where spray nozzles on the end of the boom pass over the same row middle twice (to prevent over-application). Use the formula above to determine the amount of product to use for a band application. Irrigation will be required if 1 to 2 inches of rain do not fall within 7 to 10 days after application (to ensure herbicide activation).

PRECAUTIONARY AND RESTRICTION STATEMENTS

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

RELATIVE EFFECTIVENESS OF HERBICIDES FOR TOBACCO*

Grasses and Nutsedge

Herbicide	Barnyard-grass	Broadleaf Signalgrass	Crab-grass	Crowfoot grass	Fall Panicum	Fox-tails	Goose-grass	Johnsongrass (seedling)	Texas Panicum	Nut-sedge
Command	E	E	E	E	E	E	E	G	G	P
Devrinol	G	F	E	E	G	E	E	F	-	N
Prowl	G	G	E	E	G	E	E	G	G	N
Spartan	F	P	F	F	F	F	F	F	F	E
Tillam or Edge	G	P	E	E	G	E	G	G	P	G
Tillam or Edge + Devrinol	G	P	E	E	G	E	E	G	P	G

Broadleaf Weeds

Herbicide	Carpet-weed	Cockle-bur	Jimson-weed	Lambs-quarters	Morning-glory	Pig-weed	Purs-lane	Prickly sida	Rag-weed	Sickle-pod	Smart-weed
Command	P	F	G	G	P	P	G	E	G	P	G
Devrinol	G	N	N	G	N	G	G	N	F	P	P
Prowl	G	N	N	G	N	G	G	N	N	P	P
Spartan	G	G	G	G	G	G	G	G	F	--	G
Tillam or Edge	G	N	N	G	N	G	G	N	N	P	P
Tillam or Edge + Devrinol	G	N	N	G	N	G	G	N	F	P	P

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

PLANT BED WEED CONTROL

Weed Problem	Chemical	Product	Rate/100 sq. yds	Remarks
Weeds, nematodes, insects, (see remarks)	methyl bromide (98%) + chloropicrin (2%)	Brom-O-Gas (cans)	9.0-18.0 lbs	Fall fumigation is preferred. Prepare seedbed as you would for seeding. You must use an air-tight cover. Treat at soil temperatures above 55°F. Expose soil to chemical for at least 24 hours and then aerate 24 to 48 hours before seeding. The hot-gas method will permit shorter exposure time. METHYL BROMIDE IS EXTREMELY POISONOUS. **Read precautionary statements.**
		Terr-O-Gas 98 (cylinders)	9.0-18.0 lbs	
	methyl bromide (69%)	MBC	9.0 lbs	
Weeds, nematodes, insects, damping-off, black shank	dazomet (99%)	Basamid Granular	7.5 lbs	Fall application is strongly encouraged. Prepare seedbed as you would for seedling. Soil temperatures **must** be above 43°F. Spread uniformly, incorporating to a depth of 8 inches. Cover with plastic immediately. Thoroughly seal the cover along the margins of the bed. Remove covers 5-7 days after treatment and aerate according to the label. A germination test should be conducted before seeding to ensure that no gas residues remain. Waiting periods between treatment and seeding should be 11-47 days, depending upon soil temperature, structure, and moisture. **Read precautionary statements.**

PLANT BED WEED CONTROL

Weed Problem	Chemical	Product	Rate/100 sq. yds	Remarks
Weeds, nematodes, insects, damping-off, black shank (cont.)	methyl bromide (66%) + chloropicrin (33%)	Terr-O-Gas 67	13.5 lbs	Same as for previous remarks. Use higher rates for high pest infestations. **Read precautionary statements.**
		Tri-Con 67/33	9.3 lbs	
	metham (32%) (SMDC)	Vapam	1.5 gals	Fall fumigation is preferred. Prepare seedbed as you would for seeding. Apply to freshly prepared moist soil when temperature is above 55°F. Tarp Method: Inject chemical to a depth of 5 inches or spray or drench at rate of 1.5 gal in 40 gal of water per 100 sq. yds. Apply uniformly over the entire area. Cover area immediately with plastic for no less than 1 day, but no more than 2 days. After removing plastic, cultivate soil lightly and wait 7 to 14 days before planting in treated area. **Read precautionary statements**.
	metham (42%) (SMDC)	Sectagon 42	1.25 gals	
Emerged grasses	sethoxydim	Poast	2 tsp (0.33 oz) + 4 tsp (0.67 oz) of crop oil concentrate	Apply to actively growing grasses at 40-60 psi in 5 - 20 gal/A through hollow cone or flat fan nozzles only. Read precautionary statements.
White clover	napropamide	Devrinol 10G	4.5 oz	Apply at seeding and thoroughly incorporate. Be careful to not over-apply. One 12 oz. container should cover 267 sq. yds. Read precautionary statements.

WEED CONTROL IN DARK-FIRED TOBACCO FIELDS

Weed Problems	Soil[1] Texture	Chemical Lbs Active Ingredient/A	Product per Acre	Applic.[2] Method	Remarks
Barnyardgrass, broadleaf signalgrass, crabgrass, field sandbur (suppression), foxtails, seedling Johnsongrass, fall panicum, velvetleaf, jimsonweed, lambsquarter, prickly sida, purslane, spurred anoda, venice mallow, common ragweed, smartweed, cocklebur (suppression), shattercane		clomazone	Command 4EC	PPI	Use the higher rate for heavy weed pressure or heavy soils. Best results are obtained when the product is incorporated no more than 1 inch deep. Transplants should be placed below the treated area. Do not use in plant beds. Read precautionary statements.
	Coarse	0.75	1.5 pts		
	Fine	1.0	2.0 pts		
	Coarse	clomazone	Command 3ME	OT	
	Fine	0.75	2.0 pts		
		1.0	2.7 pts		
Barnyardgrass, carpetweed, crabgrass, fall panicum, foxtails, goosegrass, johnsongrass from seed, lambsquarters, pigweed, common purslane, ragweed (suppression), ryegrass, check label for uncommon weeds.		napropamide	Devrinol DF,	PPI,	For PPI application, incorporate the same day as applied. Small grain injury may occur with PPI application method. Read precautionary statements.
	Coarse	1.0	2.0 lbs.	OT,	
	Med-ium	1.0-1.5	2.0-3.0 lbs.	Layby	
	Fine	2.0	4.0 lbs.		
			Devrinol 2E	PPI	
	Coarse	1.0	2 qt	only	
	Med-ium	1.0-1.5	3 qt		
	Fine	2.0	4 qt		

WEED CONTROL IN DARK-FIRED TOBACCO FIELDS

Weed Problems	Soil[1] Texture	Chemical Lbs Active Ingredient/A	Product per Acre	Applic.[2] Method	Remarks
Barnyardgrass, bermuda grass, crabgrass, Florida pusley, foxtails, goosegrass, ground cherry, lambsquarters, henbit, pigweed, purslane, purple nutsedge, yellow nutsedge.	All types	pebulate 4.0 + fonofos 1.0	Edge 1.0 gal	PPI	Incorporate *immediately* after application. Read precautionary statements.
Barnyardgrass, bermudagrass, blackeyed susan, crabgrass, foxtails, Florida pusley, goosegrass, henbit, lambsquarters, millet, common purslane, pigweed, ragweed (suppression), shepherdspurse, signalgrass, purple nutsedge, wild oats, yellow nutsedge.	All types	pebulate 4.0 + fonofos 1.0 + napropamide 1.0	Edge 1.0 gal + Devrinol 50 DF, 50WP 2.0 lbs	PPI	Transplanted tobacco. Incorporate *immediately* after application. Read precautionary statements.
Annual spurge, barnyardgrass, carpetweed, crabgrass, crowfoot grass, Florida pusley, foxtails, goosegrass, johnsongrass from seed, lambsquarters, panicums, pigweed, purslane, signalgrass.	Coarse Med-ium Fine	pendimethalin 0.75 0.75-1.0 1.0-1.25	Prowl 3.3 EC 1.8 pts 1.8-2.4 pts 2.4-3.0 pts	PPI, Layby	Apply chemical up to 60 days prior to transplanting and incorporated into the soil within 7 days after application. Read precautionary statements.

WEED CONTROL IN DARK-FIRED TOBACCO FIELDS

Weed Problems	Soil[1] Texture	Chemical Lbs Active Ingredient/A	Product per Acre	Applic.[2] Method	Remarks
Cocklebur, Florida pusley, hairy galinsoga, groosegrass, groundcherry, jimsonweed, seedling Johnsongrass, lambsquarters, morningglory, wild mustard, nightshade, nutsedge, orchardgrass, pigweed, prickly sida, Suppresses barnyardgrass, crabgrass, crowfootgrass, foxtail, panicums, signalgrass. Check label for uncommon weeds.	Coarse Med-ium Fine	sulfentrazone	Spartan 75DF 5.3 oz 6.7 oz 8.0 oz	After bedding, before transplanting	Apply this product only as specified on the label. Do not apply to soils classified as sands with less than 1% organic matter and shallow groundwater. Do not impregnate on fertilizer. Apply to soil surface after field has been prepared for planting. Apply within 14 days of transplanting, **after** beds are knocked down for planting. **Do not** apply at or after transplanting. Do not disturb treated soil below a 2 inch depth. Crop damage can occur under some conditions. **Do not apply** Spartan more than once per season. Do not seed small grains within 4 months of application. Do not plant cotton or canola within 18 months of use. **Read precautionary statements.**

WEED CONTROL IN DARK-FIRED TOBACCO FIELDS

Weed Problems	Soil[1] Texture	Chemical Lbs Active Ingredient/A	Product per Acre	Applic.[2] Method	Remarks
Barnyardgrass, bermudagrass, crabgrass, crowfoot grass, Florida pusley, foxtails, goosegrass, ground cherry, lambsquarters, henbit, pigweed, purslane, purple and yellow nutsedge, check label for uncommon weeds	All types	pebulate 4.0	Tillam 6E - 2.6 qts Tillam 10G - 40.0 lbs	PPI	Incorporate immediately after application. Read precautionary statement.
Barnyardgrass, bermudagrass, blackeyed susan, crabgrass, foxtails, Florida pusley, goosegrass, henbit, lambsquarters, millet, pigweed, common purslane, ragweed (suppression), shepherdspurse, signalgrass, purple and yellow nutsedge, wild oats, check label for uncommon weeds	All types	pebulate 4.0 + napropamide 1.0	Tillam 6E 2.6 qts + Devrinol 2E or 50DF- 2.0 qt or 2.0 lbs	PPI	Incorporate immediately after application. Read precautionary statements.

[1]When the soil has less than 1% organic matter, use the rate for the coarse soil texture recommendations. Coarse - sands, loamy sands, sandy loams; Medium - sandy clay loams, silts; Fine - clay loams, silty clay loams, clays.
[2]PPI - Preplant incorporated. Delay in growth may result under adverse conditions and/or when poor application practices have been used. OT - Over-the top after transplanting as a band or broadcast application. Layby - Application of herbicide in row middle after last cultivation.

INSECTS ON TOBACCO

Paul J. Semtner, Extension Entomologist

MANAGEMENT OF TOBACCO INSECTS

Several insect pests pose serious threats to Virginia's tobacco crop. Insects can injure tobacco in the field, plant bed, greenhouse, and in storage. Some insects are annual problems. Other insects require control in some years, but not in others. The proper management of these pests prevents economic reductions in tobacco yield and quality and reduces the amount of insecticide used. All tobacco growers should adopt an integrated pest management (IPM) approach to pest control. IPM uses all available practices including chemical, cultural, and natural controls to maintain pest populations below levels that cause economic crop losses. It promotes the application of pesticides only when they are needed. IPM takes into account that a certain amount of insect damage will not reduce tobacco yield or quality enough to pay for the cost of treatment including insecticide, fuel, labor, and equipment. As a result, IPM helps to maximize profits. The use of IPM reduces production costs, pesticide residue levels, environmental contamination, and human exposure to pesticides. It also encourages beneficial predators, parasites and pathogens that help to regulate insect pest populations.

Chemical controls

The action or treatment threshold and field scouting are important tools in IPM. The treatment threshold is that population of a pest or injury level that requires treatment with an insecticide to prevent economic damage to the crop. The timing of foliar insecticide applications is based on regular field scouting to determine when pests reach their treatment thresholds. Foliar insecticides are applied at the threshold to control one or more pests. Application of an insecticide before the threshold is reached can result in overuse of pesticides, increased production costs, environmental contamination, and pesticide residues. However, delay in the application of an insecticide after the threshold is reached can allow excessive damage that reduces tobacco yield and quality. Foliar and soil-applied insecticides are extremely important tools in a pest management program. Even with many cultural and natural controls to reduce insect outbreaks, it is almost impossible to grow a high yielding, high quality tobacco crop without using insecticides.

Cultural controls

Cultural control practices can help reduce insect infestations and decrease the need for insecticide applications. Cultural practices that help to manage insect pests on tobacco include:

1. **Early plowing in the spring**. This practice reduces wireworm and cutworm infestations.
2. **Destruction of plant beds immediately after the completion of transplanting**. This practice prevents aphids, flea beetles and other insects from building up high populations in plant beds and moving to field tobacco.
3. **Management of field borders**. Keep field margins clear of weeds and tall grass. Grasshoppers, cutworms and other insects can move from these sites to tobacco fields.
4. **Early topping in the button or prebutton stage**. Early topping eliminates food sources for budworms and makes the tobacco plant a less desirable host for aphids and hornworms. It also improves yield when insects are not a problem.

5. **Effective sucker control**. Sucker control reduces food sources for hornworms, budworms and aphids.

6. **Root destruction**. Stalk cutting and root destruction immediately after harvest reduces food and overwintering sites for hornworms, budworms, and flea beetles. This practice is most effective when done on an area wide basis.

7. **Crop rotation**. Rotation of tobacco with certain crops can reduce infestations of wireworms, cutworms and white-fringed beetles.

Various cultural practices reduce feeding and overwintering sites of several insect pests. Early topping, effective sucker control, and proper nitrogen fertilization reduce insect populations later in the current growing season. Stalk cutting and root destruction reduce insect populations overwintering into the next year.

Natural Controls

Tobacco producers often overlook the benefits of natural controls. An important group of parasites and predators help maintain populations of budworms below damaging levels in many years. One parasitic wasp (*Campoletis sonorensis*) kills more than 80% of the budworms in tobacco fields about half the time. This level of budworm control is as good as that obtained with some of the best foliar insecticides. Hornworms and aphids also have large numbers of predators on tobacco. In addition, a fungal pathogen helps control aphids late in the season. Certain weather conditions are also effective in reducing pest problems. The combination of high temperature and predator activity or high humidity and a fungus disease can rapidly reduce aphid populations. Take into account beneficial insects when deciding whether to apply an insecticide for control of a pest insect. Use treatment thresholds to time applications of insecticides to reduce their impact on beneficial insects. You can also select insecticides that are less harmful to beneficials. *Bacillus thuringiensis* (Dipel/SOK-BT/Biobit) and Lannate have low toxicity to beneficials. Pretransplant soil-applied nematicide-insecticides such as Nemacur and Furadan are harmful to some beneficial insects. High populations of predators are usually associated with aphid infestations on tobacco. However, beneficials usually do not reduce aphid populations until after serious damage has already occurred.

Insect Control in the Tobacco Plant Bed

Healthy transplants are essential for the production of a uniform, fast growing tobacco crop that is easy to manage. Several insects can cause serious problems that affect the stand, uniformity, and growth of tobacco seedlings in the plant bed. Adult tobacco flea beetles riddle the leaves of seedlings with many holes, while the larvae (grubs) feed on the roots. Cutworms can destroy a plant bed quickly by cutting off and killing individual plants or by feeding on the leaves. Vegetable weevil larvae feed in the buds of seedlings causing damage similar to that caused by budworms. Aphids can build up moderate populations in plant beds but they rarely injure the seedlings. However, if aphids are carried to the field on transplants, they can cause early-season infestations.

Although insects can cause serious problems in tobacco plant beds, high quality transplants can be produced without extensive use of insecticides. A preseeding or postemergence application of Di-Syston 15G provides effective control of flea beetles and aphids, but not cutworms. Remedial applications of foliar insecticides will control most insect pests in tobacco plant beds. **Check plant beds once or twice a week for insect infestations. If insects become a problem, apply an insecticide recommended for their control.**

Keep the area within 100 ft of the plant bed free of tall weeds, decaying plant material, and trash to eliminate hiding places for overwintering tobacco insect pests. Keep

spring gardens and weeds such as dock, wild mustard, and horsenettle away from plant beds because they can harbor aphids, flea beetles and other pests that can move into plant beds. The destruction of plant beds immediately after the completion of transplanting will eliminate potential breeding sites for tobacco insects and pathogens.

Insect Control on Transplants Produced in the Greenhouse

Production of tobacco transplants in greenhouses has increased dramatically in Virginia during the 1990s. So far insects have not caused serious problems in greenhouses, but several have the potential to become serious pests. In addition, only three insecticides are available for use on tobacco transplants in the greenhouse. Cutworms and slugs usually feed on stems and leaves at night. Cutworms also cut off and destroy plants. Vegetable weevil larvae often feed in and destroy the buds of seedlings. Crickets feed on young seedlings causing reduction in growth and stands. Ants can carry off seeds and cause poor stands. Grubs feed on and uproot plants. Aphids may build up high populations that reduce plant vigor, produce honeydew that causes plants to stick together, and can be carried to the field on infested plants.

Cultural controls

Keep the area around the greenhouse clean and free of weeds, decaying plant material, leaves, hay, plastic, rocks and other protected sites for insect pests. Cutworms, slugs, crickets, grasshoppers and vegetable weevils move into greenhouses from these sheltered areas. Winged aphids can fly into greenhouses from nearby weeds and establish colonies on tobacco seedlings. If other crops are grown in greenhouses allow a fallow period between crops. This reduces the chances that pests such as aphids or whiteflies will carry over to the tobacco seedlings. Very cold or hot conditions during this fallow period can reduce potential pest problems.

Chemical control

Orthene is the only effective insecticide labeled for use on tobacco transplants grown in greenhouses. It provides good to excellent control of aphids, cutworms, and flea beetles and vegetable weevils. Orthene should be applied to the seedlings as a foliar spray and not in the float water. Apply the proper rate of Orthene because over application can injure or kill young plants. Greenhouse research by Dr. Sterling Southern at North Carolina State University indicates that the application of Orthene with flat fan and solid cone nozzles gives better aphid control than that applied with hollow cone nozzles. MPede is labeled for use on greenhouse tobacco seedlings. It is not effective against the tobacco aphid, but gives fair control of whiteflies. Metaldehyde (Deadline Bullets) bait controls slugs and snails in the greenhouse. Do not use methaldehyde in float beds.

Insect Control on Newly Transplanted Tobacco

Wireworms

Recently wireworms have increased in importance as pests of tobacco in Virginia. This increase may be related to decreases in the use of certain nematicide-insecticides and an increase in the use of pesticides that are less effective against wireworms. Wireworms are the larval stages of click beetles. They are hard, yellowish-brown, wire-like grubs that live in the soil and tunnel the roots and piths of young tobacco plants. Damage to plants is first noticed 2 to 6 weeks after transplanting. This injury stunts plant growth, causes irregular stands and reduces yields. The wireworm life cycle takes about a year to complete. The larvae emerge from eggs in the late summer and fall, feed on the roots of various host plants, and

overwinter into the next year. Larvae then feed on newly transplanted tobacco. They pupate and emerge as adult click beetles during late spring or early summer. Beetles deposit eggs in the soil during June and July. Wireworms are most common in tobacco fields with a history of problems, or in those previously planted in sod, weeds, corn or small grains. In these situations, apply a soil insecticide and incorporate it by double disking at least 2 weeks before transplanting. Plowing fields in early spring will help reduce wireworm infestations. Use sturdy, healthy transplants because they are less susceptible to wireworm damage than tender transplants. After wireworm damage has occurred, it is too late to apply an insecticide. If a stand is seriously reduced, turn the crop under and replant after treatment with a recommended soil insecticide. If replanting is not possible, cultivation and irrigation may help plants recover and reduce losses.

Cutworms

Cutworms are active at night, feeding on leaves and cutting off leaves and plants. This injury can cause enough damage and stand loss to require replanting. Cutworm infestations are very sporadic and difficult to predict. However, plowing fields in the early spring usually reduces cutworm populations. Detect potential cutworm problems by placing clumps of green clover at various locations throughout late plowed fields. If large numbers of cutworms are present under the clumps after 3 to 7 days, apply a pretransplant insecticide or transplant water treatment for cutworm control. Otherwise, check fields for cutworm damage once or twice a week during the first month after transplanting to determine when a remedial foliar treatment is needed.

Selecting Soil Incorporated Insecticides

Pretransplant applications of systemic soil insecticides can provide effective control of wireworms, flea beetles, aphids, cutworms, and nematodes on tobacco. Consider several factors before selecting a soil insecticide. First, determine whether nematodes are a problem in the field as described in the disease control section of this guide. Furadan, Lorsban, Mocap, Nemacur, and Vydate control both insects and nematodes. Apply soil insecticide for control of wireworms if tobacco is planted after sod, weeds, corn or small grain or has a history of wireworm problems. Mocap and Loroban are labeled at lower rates for wireworms than for nematodes. Nemacur does not control wireworms. Therefore, when Nemacur is used for nematode control another chemical may be needed to control wireworms.

Soil applications of Furadan and Nemacur act as systemic insecticides to control various insect pests feeding on tobacco foliage. If aphids are a problem year after year, control them with an application of Admire in the transplant water or to greenhouse float plants. However, proper scouting of fields and the application of foliar insecticides at the insect's threshold is an effective and may be less expensive alternative to the use of Admire. Admire applied in the transplant water or to greenhouse float plants often gives season-long control of aphids and early season control of flea beetles, Admire does not control nematodes. Nemacur will provide some early-season aphid control, but foliar insecticide applications are usually needed for aphid control. Furadan controls flea beetles and aids in the control of budworms, but it is not effective against aphids However, several foliar insecticides and transplant water treatments are good alternatives to the use of Furadan. Orthene and Admire applied in the transplant water provide good early-season (2- to 4-week) control of flea beetles. Orthene transplant water treatment also gives some early season control of aphids and cutworms, while Admire provides season long control of aphids.

Table 1. Rating of soil and transplant water treatments for control of insect pests on flue-cured tobacco.

Insecticide	Leaf feeding insects		Soil insects		Nematodes	
	Aphids	Flea Beetles	Cutworms	Wireworms	Root-knot and others	Tobacco Cyst
Admire (TPW or Greenhouse transplant drench)	5	3	0	3	0	0
Dyfonate	0	2	3	4	0	0
Furadan 4F	0	4	2	3	1	0
Lorsban	0	2	3	4	1 (5qt/acre)	0
Mocap	0	2	2.5	3.5	1	0
Nemacur	2	2	0	1	3	0
Orthene (TPW)	2	3	3.5	0	0	0

Ratings are based on a scale of 0 to 5 where 0 = not labeled or no control, 1 = poor control, 2 = fair control, 3 = good control, 4 = very good control, and 5 = excellent control.

***Ratings for nematode control were made by Dr. Charles S. Johnson.**

Remedial Control of Insects on Larger Tobacco

Scouting Tobacco Fields for Insects

Scout tobacco fields at least once a week throughout the season to determine when insect pests are abundant enough to require treatment.

1) Accurate samples of insect pests are essential for determining the proper timing of insecticide applications. Samples should consist of the number of insects and their damage on at least 50 plants in each field. Make and record counts on 5 consecutive plants at each of 10 different locations throughout the field. Large fields greater than 5 acres will require proportionally larger samples.

2) Compare counts of insects to the threshold levels listed in Table 2.

3) If pest populations meet or exceed the treatment thresholds, apply a labeled insecticide for their control.

4) Hornworms, budworms, flea beetles, and aphids are primary targets of an insect scouting program because they are the most important insect pests that feed on tobacco foliage in Virginia.

5) When scouting a field for insects, check individual plants as follows:

   a. First, check the bud region for budworm damage.

   b. If damage is present, look carefully for budworms and the white cocoons of the budworm parasite, *Campoletis sonorensis*. Do not count the plant as infested if you do not find a budworm.

   c. Examine the undersides of lower-, mid-, and upper-stalk tobacco leaves for aphids.

   d. Check the entire plant for hornworm damage, locate the hornworms, note their size and whether they are parasitized by *Cotesia congregata* (white egg-like cocoons on hornworm's back).

   e. Check the upper surfaces of the middle and lower leaves for honeydew, flea beetles and shot hole-like feeding holes of flea beetles.

   f. If you find an unidentified insect that is causing serious damage to the crop, collect the insect and samples of its damage and take it to a local Extension

agent for identification. This is important because beneficial insects are often mistaken for pests. In addition, the misidentification of a pest may result in the selection of the wrong insecticide for its control.

6) Treat tobacco fields when one or more insect pests meet or exceed the treatment threshold levels given in Table 2.

Table 2. Treatment thresholds for various insects on tobacco.

Insect	Treatment threshold
Aphids	10 or more adult aphids per upper leaf on 5 of 50 plants. Larger numbers can be tolerated after topping.
Budworms	5 larvae (worms) per 50 plants until 1 week before topping.
Cutworms	5 out of 100 plants with recent cutworm damage.
Flea beetles	4 beetles per plant on newly transplanted tobacco (less than 2 weeks old), 8 to 10 beetles per plant on 2 to 4 weeks-old plants, 60 beetles per plant on tobacco more than 4 weeks old.
Grasshoppers	5 grasshoppers per 50 plants.
Hornworms	5 larvae (worms) at least 1 inch long per 50 plants. Do not count worms with cocoons of the hornworm parasite on their backs. For hornworms ½ to ¾ inch long, treat when there is 1 worm per plant.

Tobacco Budworms

Tobacco budworm larvae feed in the buds of young tobacco plants causing many holes in the tiny developing leaves. As these leaves increase in size, the feeding holes increase proportionally giving the leaves a ragged, distorted appearance. Budworms sometimes top tobacco plants. This results in early sucker growth that can cause plant stunting and the need for hand suckering. **Initiate control of tobacco budworms anytime before buttoning when there are 5 or more living budworms per 50 plants.** Budworms rarely cause economic damage to tobacco after the button stage, although they sometimes tunnel into the upper stalk after topping. Apply foliar sprays for budworm control with 1 or 3 solid-cone or hollow-cone nozzles over each row using 40 to 60 pounds pressure (psi) to deliver 10 to 25 gallons of spray mixture per acre. Control with foliar sprays rarely exceeds 80 percent. However, *Bacillus thuringiensis* (Dipel) baits (commercial or homemade) applied by hand or with a granular applicator usually give better than 90 percent control. See insecticide performance ratings in Table 3. When checking tobacco for budworms, you may see the cocoons of a wasp (*Campoletis*) that parasitizes budworms on the leaves near the bud. These cocoons are about ¼ inch long and white or grayish in color with two black bands. They are often mistaken for budworm cocoons, which are reddish-brown, about ¾ inch long, and formed in the soil beneath the plant. Living budworms are rarely found on plants with *Campoletis* cocoons in the bud region. *Campoletis* provides good natural control of budworms on tobacco in Virginia.

Table 3. Rating of foliar insecticides for control of insect pests on flue-cured tobacco.

Insecticide	Aphids	Bud-worm	Cut-worm	Flea-beetle	Grass-hopper	Horn-worm
Agree, Javelin, Dipel, Biobit, MVP, Maatch (*Bacillus thuringiensis*) Spray	-	F	-	-	-	E
Dipel, (*Bacillus thuringiensis*) Bait	-	E	-	-	-	F
Lannate	F	G	-	G	-	E
Orthene	VG	F-G	VG	G	VG	E
Provado	VG	--	--	G	--	--
Sevin	-	F	G	G	F	VG
Thiodan/Golden Leaf Tobacco Spray/Phaser	G	F	-	G	-	E

Rating is as follows - = not labeled, P = poor, F = fair, G = good, VG = very good, E = excellent.

Hornworms

Hornworms are large caterpillars (up to 4 inches long) that consume large amounts of tobacco leaf. Infestations may develop anytime from transplanting until harvest, but the most severe damage occurs during June, August, and September. **Begin control when there are 5 hornworms an inch or more in length per 50 plants. Do not count** hornworms with white egg-like cocoons of the parasitic wasp, *Cotesia congregata*, on their backs. These eat much less than healthy hornworms. They also provide a source of parasites that help reduce the next generation of hornworms. When you find large numbers (1 or more per plant), of small hornworm larvae (½ - ¾ inch long), apply an insecticide for their control. Predators kill large numbers of larvae less than 1 inch long. Direct sprays to the upper one-half of the plants for optimum control. See insecticide ratings in Table 3. Several cultural practices help manage populations of hornworms. Early topping, early transplanting, and effective sucker control reduce late-season infestations. Stalk cutting and root destruction on an area-wide basis immediately after harvest reduce overwintering populations.

Aphids

The tobacco aphid has been the most severe insect pest of tobacco in Virginia for the past two decades. It may infest tobacco seedlings in plant beds, but the most severe damage occur on field tobacco from late June to August. Aphids are sometimes introduced into the field on infested tobacco transplants. However, the most important source of infestation are winged aphids that fly into fields and deposit young wingless aphids on tobacco plants. High populations of aphids can reduce tobacco yield by 5 to 25 percent (100 to 500 lbs/acre or more) under some growing conditions. Aphids deposit a sticky, shiny honeydew on tobacco leaves. A dark, sooty mold often grows on the honeydew. Sooty mold and honeydew interfere with curing and reduce leaf quality. Sooty mold and honeydew on tobacco indicate that aphids have been a problem, but they often remain on tobacco after aphids have been controlled.

A red form of the tobacco aphid has been common on tobacco in Virginia for the last 11 years and has almost completely replaced the green form. It reproduces more quickly and at higher temperatures than the green form and is more difficult to control with insecticides.

Watch for aphids from early June to the end of August. Examine the undersides of leaves from the lower, middle, and upper portions of tobacco plants at regular intervals to determine the extent of aphid population buildup. You also should be on the lookout for honeydew and sooty mold. **Initiate insecticide treatments for aphid control when 5 of 50 plants have about 10 aphids per upper leaf. Moderate numbers (less than 50 per leaf) of aphids can be tolerated after topping.**

Use the following practices to manage aphids on tobacco:

1. **Make remedial applications of foliar insecticide at the treatment threshold** before aphid populations become too high and are more difficult to control. If you control aphids early, they are much easier to control for the rest of the season. See insecticide ratings in Table 2.

2. **Give the insecticide time to work**. Wait at least 3 to 4 days after application before assessing control because these chemicals require 1 to 3 days to bring aphid infestations under control. If control is poor, recheck your calibration and spraying equipment before making another application. Make another application of insecticide if control is poor and more than ¼ inch of rainfall occurs within 6 hours after application.

3. **Obtain good coverage with foliar insecticides**. Some insecticides must be applied to the undersides of the leaves where most aphids are found for effective aphid control. The use of higher gallonage (25 to 50 gal/acre), higher sprayer pressure (at least 60 psi), drop nozzles, and spreader-stickers can improve coverage.

4. **Continue to check fields after satisfactory control has been obtained.** Aphid populations can build up rapidly and require additional insecticide applications.

5. **Rotate insecticides**. If one insecticide does not control aphids, use another in a different class. For example, if Orthene does not control aphids, try Thiodan/Golden Leaf Tobacco Spray/Phaser. If neither chemical controls aphids, Lannate may provide some control. Apply all insecticides as far from the next priming as possible and observe the preharvest waiting period. **Do not apply (Thiodan/Golden Leaf Tobacco Spray/Phaser) after topping.**

6. **Apply Admire in the transplant water or to greenhouse float plants.** Applications of Admire give excellent control of aphids throughout the season. The Orthene transplant water treatment and Nemacur (2 gallons/acre) broadcast treatment may give early-season control of aphids, but foliar applications of Orthene or Thiodan are usually required to prevent damage.

7. **Use cultural practices to reduce aphid populations**. Most cultural practices do not keep aphid populations below the treatment threshold but they can reduce the need for insecticide applications after topping. Useful cultural practices include:

    a. **Locate gardens at least 100 yards from plant beds or greenhouses**. Garden greens and related weeds are sources of aphids in the spring.

    b. **Control aphids in plant beds and greenhouses**. This reduces the chances that aphids will become established in the field early in the season. Destroy plant beds after transplanting is completed.

    c. **Transplant early**. Early planted tobacco becomes infested with aphids earlier, but it matures earlier and have less impact on tobacco planted later in the season.

    d. **Use recommended nitrogen rates**. High rates of nitrogen delay ripening and promotes excessive sucker growth that favors infestations of aphids and hornworms.

    e. **Top early**. Aphid populations decline rapidly after topping, especially during hot, dry weather. However, fields should still be

watched closely after topping because numbers of aphids can quickly build up to levels that require control.

Tobacco Flea Beetle

Adult tobacco flea beetles feed on the leaves and stalks of tobacco in the plant bed and in the field, while their grubs or larvae feed on tobacco roots. Extensive feeding by both beetle stages on newly set transplants may cause stunting of scattered plants in the field resulting in uneven stands. When checking tobacco fields for flea beetles, look for the characteristic 'shot-hole' feeding damage, and then count the flea beetles on 20 plants (2 per field-sample location). **Apply treatments for tobacco flea beetles on newly set tobacco when there are 4 or more beetles per plant**. Larger plants can tolerate very high flea beetle densities, but an insecticide treatment should be applied when the bases of the lower leaves have a netted appearance or densities exceed 60 beetles per plant. See Table 3 for flea beetle control ratings for foliar insecticides. Harvesting of leaves at the normal time, and stalk cutting and root destruction immediately after harvest are the most effective cultural practices for reducing damage caused by flea beetles. Use drop nozzles for late-season control.

Insecticide Application Methods

Apply insecticides properly for the best control of insects. On small tobacco, obtain effective control of insects by directing one solid-cone or hollow-cone nozzle per row to the bud. Operate equipment at 40 to 60 pounds pressure, do not exceed 4 ½ miles per hour, and use at least 6 to 8 gallons of mixed spray per acre. After tobacco is 2 ft. tall, use one or three cone nozzles per row. If three nozzles are used, orient the two side nozzles at a 45 degree angle toward the upper 1/3 of the plant. When treating for budworms use 5 to 6 inch side pipes instead of 10 to 12 inch pipes to improve control. Use 40 to 60 pounds pressure (60 to 100 lbs. psi for aphids) and 20 to 50 gallons of spray mixture per acre. Set the nozzles 12 to 18 inches above the tobacco. Drop nozzles oriented to the undersides of the leaves and used in combination with 1 or 3 nozzles over the row may improve aphid and flea beetle control.

Table 4. Restricted entry intervals (REI) and preharvest intervals for various insecticides used on flue-cured tobacco in Virginia.

Insecticide	Restricted entry intervals (hours)	Preharvest interval (days)
Foliar treatments		
Acephate (Orthene)	24	3
Bacillus thuringiensis (Agree/Biobit, Condor, Dipel/Javelin/MVP)	4	0
Carbaryl (Sevin)	12	0
Endosulfan (Golden Leaf Tobacco Spray/ Phaser/Thiodan)	24	5
Methomyl (Lannate)	48	7
Provado	12	14
Soil treatments		
Carbofuran (Furadan)	48	"
Chlorpyrifos (Lorsban)	24	"
Ethoprop (Mocap)	48	"
Fenamiphos (Nemacur)	48	"
Fonofos (Dyfonate)	48	"
Metaldehyde (Deadline Bullets)	12	"
Oxamyl (Vydate)	48	"
Greenhouse float tray or transplant water treatment		
Imidacloprid (Admire)	12	"

Plant Bed Insects

Insect	Insecticide and Formulation	Rate per 100 sq yds	Remarks and Precautions
Aphids, flea beetles (preventive control)	Disulfoton (Di-Syston) 15G	9 oz	Broadcast granules evenly over plant bed just before seeding or after plants have emerged and are ½ to 1 inch in diameter. Rake in preseeding treatment or water in post-emergence treatments. Do not apply to plant bed more than once per season. Do not use Di-Syston 8E as it may be phytotoxic. **Restricted Use.**
Aphids, flea beetles	Acephate (Orthene) 75S	1 tbs in 3 to 6 gal water (1 lb per acre)	Spray plants as needed. Do not pull plants until 24 hours after treatment. Carbaryl (Sevin) spray or dust should not be used in plant beds because it may harm young seedlings. Cole crops such as turnips, collards and cabbage should not be planted near plant bed sites.
	Endosulfan (Golden Leaf Tobacco Spray) 3EC	⅔ qt/100 gal (3 to 6 gal/100 sq yds)	
Grass-hoppers, vegetable weevils	Acephate (Orthene) 75S	1 tbs in 3 to 6 gal of water (1 lb/acre)	
Cutworms	Acephate (Orthene) 75S	1 tbs in 3 to 6 gal of water (1 lb/acre)	Make spray applications to plant beds and adjacent alleys during late afternoon. Cutworms are active at night.
	Carbaryl (Sevin) 5% Bait	½ to 1 lb	Apply to alleys around plant bed. Do not apply directly to plants. May be phytotoxic.
Green June beetle larvae	Carbaryl (Sevin) XLR Plus 4EC	11 tbs in 50 to 100 gal of water (8 qt/acre)	Treat only affected areas. Apply as a drench using a sprinkler can. Make applications when insects appear or feeding is noticed. Methyl bromide, when applied prior to seeding for weed control, will kill grubs present.
	Endosulfan (Thiodan) 50WP	½ lb in 100 gal of water	
Snails and slugs	Hydrated or air slacked lime	4 lb	Lime dust applied to the soil surface in a band 3 to 4 inches wide along the margin of the bed may act as a barrier. Apply during late afternoon or evening.
	Metaldehyde (Deadline Bullets) 4% bait	¼ to 1 lb	Apply to the soil surface in alleys and vacant areas in the plant bed in late afternoon. Do not apply directly on the foliage.

Tobacco Transplants Grown in Greenhouses

Insect	Insecticide and Formulation	Rate per 1000 sq. ft.	Remarks and Precautions
Aphids, cutworms, flea beetles	Acephate (Orthene) 75S	1 tbs per 3 gal of water	Apply evenly to the foliage as a spray. Over application may cause phytotoxicity. **Do not apply through an irrigation system. Over application can cause plant injury.**
Snails and slugs	Metaldehyde (Deadline Bullets) 4% bait	¼ to 1 lb	Apply to alleys, walkways and vacant areas in late afternoon. **Do not apply to float water or directly on foliage.**

Insects on Field Tobacco-Drench Application to Greenhouse Transplants

Insects	Insecticide and Formulation	Rate per 1,000 plants	Remarks and Precautions
Aphids, Flea Beetles	Imidacloprid (Admire) 2F	1.0 fl oz.	Apply as a drench to trays or flats prior to transplanting. Mix with water before application. Keep agitated or mix regularly to avoid settling in tank. Water plants immediately after application using enough volume to remove any white Admire residue from the transplant foliage and wash into the potting media. Transplant into the field within 3 days.
---	---	---	
Wireworms	Imidacloprid (Admire) 2F	1.4 to 2.8 fl. oz.	

Insects on Field Tobacco - Pretransplant Soil Treatments

Insect	Insecticide and Formulation	Rate per acre	Remarks and Precautions
Aphids (Aids in control)	Fenamiphos (Nemacur) 3EC	2 gal	Nemacur applied for nematode control at this rate reduces early season aphid infestations. Do not use Nemacur solely for aphid control. **Restricted use.**
Budworms (Aids in control)	Carbofuran (Furadan) 4F	1 ½ gal	Apply as a broadcast soil treatment before transplanting. Over-lapping and excessive rates may cause flecking of lower leaves and yield reductions. To reduce the possibility of plant injury, allow 14 days between application and transplanting. Respirators, goggles, and protective clothing must be worn by persons mixing, applying and incorporating Furadan. **Restricted Use.**
---	---	---	
Flea beetles, wireworms	Carbofuran (Furadan) 4F	1 to 1 ½ gal	

Insects on Field Tobacco - Pretransplant Soil Treatments

Insect	Insecticide and Formulation	Rate per acre	Remarks and Precautions
Wireworms	Ethoprop (Mocap) 6EC	1 1/3 qt to 4 qt	Make broadcast application at least 2 weeks before transplanting. Band applications are usually less effective than broadcast treatments. Do not mix granules with fertilizer or other materials. Double disk insecticides into soil immediately after application to a depth of at least 4 inches. Dyfonate is available in combination with the herbicide Tillam. Lorsban is also registered for cutworm and flea beetle larvae. **Mocap and Dyfonate are restricted use chemicals.**
	(Mocap) 10G	20 lb	
	---	---	
	Fonofos (Dyfonate) 10G	10 to 20 lb	
	(Dyfonate) 4EC	1 to 2 qt	
	---	---	
	Chlorpyrifos (Lorsban) 15G	13.5 to 20 lb	
	(Lorsban) 4E	2 to 3 qt	

Transplant Water Treatments

Insect	Insecticide and Formulation	Rate per Acre	Remarks and Precautions
Flea beetles, cutworms, thrips	Acephate (Orthene) 75S	1 lb	Provides control for 3 to 4 weeks after transplanting. Orthene also aids in control of aphids and cutworms. Orthene should be applied in at least 100 gal of water per acre (200 gals for Vydate). Higher amounts of water should be used for greenhouse transplants. Calibrate transplanters and allow tanks to run low before refilling. Vydate also acts as a nematicide. **Vydate is restricted use.**
---	---	---	
---	Oxamyl (Vydate) 2L	1 ¼ to 2 pt	
Flea beetles	---	---	
---	Imidacloprid (Admire) 2F	1.0 fl oz/ 1000 plants	
Aphids, flea beetles,	---	---	
---	Imidacloprid (Admire) 2F	1.4 to 2.8 fl oz/ 1000 plants	
Wireworms			

Insects on Field Tobacco - Foliar Treatments

Aphids	Acephate (Orthene) 75S	2/3 to 1 lb or 4 to 6 tsp per gal	Apply as a spray. Use highest rate for heavy infestations or if control was poor with previous application. If tobacco is large, use drop nozzles to orient spray to undersides of leaves for improved control. Aphids fly to tobacco fields and deposit wingless nymphs which may go unnoticed until plants become heavily infested. Prime before treating.

Insects on Field Tobacco - Foliar Treatments

Insect	Insecticide and Formulation	Rate per Acre	Remarks and Precautions
Aphids (cont'd)	Endosulfan (Thiodan/ Golden Leaf Tobacco Spray /Phaser) 3EC	2/3 to 1 1/3 qt	Apply spray evenly over entire plant, especially undersides of leaves. Repeat in 5 days if necessary. **Do not apply Endosulfan after topping.**
	Endosulfan (Thiodan) 50 WP	1 to 2 lb	
	Methomyl (Lannate) 90SP	¼ to ½ lb	Apply as a spray. Several applications may be necessary to control aphids. **Restricted Use.**
	(Lannate) 2.4LV	1 ½ pt	
	Imidacloprid (Provado) 1.6F	2 to 4 fl oz	Apply as spray.
Budworms	Acephate (Orthene) 75S	1 lb or 2 tbs per gal of water	Apply as a spray. When using hand sprayer apply in 25 gal per acre.
	Bacillus thuringiensis (Agree) WSP	1 to 2 lb	Apply as a spray. **Do not allow diluted sprays to stand more than 12 hours.**
	(Dipel) 2X	¼ to ½ lb	
	(Dipel) 4L	1 pt	
	(Biobit) FC	3 ½ pt	
	(Biobit) WP	2 lb	
	(Condor) OF	1 2/3 qt	
	(Javelin) WG	1 to 1 ¼ lb	
	(Maatch)	2 to 4 qt	
	(MPV) 0.9F	2 to 4 qt	
	Bacillus thuringiensis (Dipel) 1% homemade bait	15 to 25 lb	Prepare bait by mixing 1 lb of Dipel 2X with 99 lb of cornmeal. Apply bait to bud of each plant using a granular applicator, duster or gloved hand
	---	---	
	Dipel 10G	10 lb	

Insects on Field Tobacco - Foliar Treatments

Insect	Insecticide and Formulation	Rate per Acre	Remarks and Precautions
Budworms (cont'd)	Carbaryl (Sevin) 80S	1 ¼ to 2 ½ lb	Apply as a spray. Do not apply until plants are established and growing. The tobacco aphid often becomes a problem on tobacco following two or more applications of Sevin
	(Sevin) 50W	2 to 4 lb	
	(Sevimol) 4F	1 to 2 qt	
	(Sevin XLR Plus) 4F	1 to 2 qt	
	Endosulfan (Thiodan/ Golden Leaf Tobacco Spray/ Phaser) 3EC	2/3 to 1 1/3 qt	Apply as a spray. **Very toxic. Do not apply after topping.**
	Methomyl (Lannate) 90SP	½ lb	Apply as a spray. Make applications as needed. Direct the spray into the buds before buttoning. **Restricted Use.**
	(Lannate) 2.4 LV	1 ½ pt	
Cabbage loopers	Acephate (Orthene) 75S	1 lb or 2 tbs per gal of water	Apply as a spray in 10 to 50 gal of water
	Bacillus thuringiensis **See rates and formulations under budworms**		Apply as a spray. **Do not allow dilute sprays to stand in tank more than 12 hrs.**
	Methomyl (Lannate) 90SP	½ lb	Apply as a spray. **Restricted Use.**
	(Lannate) 2.4 LV	1 ½ pt	
Cutworms	Acephate (Orthene) 75S	1 lb	Apply as a spray overtop of plants in affected areas when 5% of plants are injured by cutworms. Make application during late afternoon using at least 25 gal of spray per acre.
Flea beetles	Acephate (Orthene) 75S	2/3 lb or 4 tsp per gal of water	Apply as a spray. Prime before treating

Insects on Field Tobacco - Foliar Treatments

Insect	Insecticide and Formulation	Rate per Acre	Remarks and Precautions
Flea beetles (Cont'd)	Carbaryl (Sevin) 80S	1 ¼ lb or 3 tbs per gal of water	Apply as a spray. Do not apply until plants are established and growing. The tobacco aphid often becomes a problem on tobacco following two or more applications of Sevin.
	(Sevin) 50W	2 lb	
	(Sevin XLR Plus) 4F	1 qt	
	(Sevimol) 4F	1 qt	
	Endosulfan (Thiodan/ Golden Leaf Tobacco Spray/ Phaser) 3EC	2/3 to 1 1/3 qt	Apply as a spray. **Do not apply after topping. Highly toxic.**
	Imidacloprid (Provado) 1.6F	4 fl oz	Apply as spray.
	Methomyl (Lannate) 90SP	¼ to ½ lb	Apply as a spray. **Restricted Use.**
	(Methomyl) 2.4 LV	¾ to 1 ½ pt	
Grass-hoppers	Acephate (Orthene) 75S	1/3 to 2/3 lb	Apply as a spray. Treat crop and a strip around field to reduce grasshopper movement into the field.
	---	---	
	Carbaryl (Sevin) 80S	2/3 to 1 7/8 lb	
	(Sevin) 50W	1 to 3 lb	
	---	---	
	(Sevimol) 4F	½ to 1 qt	
	(Sevin XLR Plus) 4F	½ to 1 ½ qt	
Hornworms	Acephate (Orthene) 75S	2/3 lb in water or 4 tsp per gal of water	Apply as a spray. Treat infested fields before worms exceed 1 ½ inches in length. Insecticides should be directed toward top six leaves of plants. Prime before treatment.

Insects on Field Tobacco - Foliar Treatments

Insect	Insecticide and Formulation	Rate per Acre	Remarks and Precautions
Hornworms (cont'd)	*Bacillus thuringiensis* (Agree) WSP	1 to 2 lbs	Apply as a spray. Do not allow dilute sprays to stand in tank more than 12 hours. Dipel can be tank-mixed with maleic hydrazide (MH-30).
	(Dipel) 2X	1/8 to ¼ lb	
	(Dipel) 4L	½ to 1 pt	
	(Biobit) EC	1 pt	
	(Biobit) WP	½ lb	
	(Condor) OF	1 2/3 qt	
	(Javelin) WG	1 to 1 ¼ lb	
	(Maatch)	1 to 4 qt	
	(MPV) 0.9F	1 to 4 qts	
	Carbaryl (Sevin) 80S	1 ¼ to 2 ½ lb in 25 gal of water or 3 tbs per gal of water	Apply as a spray.
	(Sevin) 50W	2 to 4 lb	
	(Sevin XLR Plus) 4F	1 to 2 qt	
	(Sevimol) 4F	1 to 2 qt	
	Endosulfan (Thiodan/ Golden Leaf Tobacco Spray/ Phaser) 3EC	2/3 to 1 1/3 qt	Apply as a spray. **Do not apply Endosulfan after topping.**
	Methomyl (Lannate) 90SP	1/4 to ½ lb in 25 gal of water	Apply as a spray. **Restricted Use.**
	(Methomyl) 2.4 LV	¾ to 1 ½ pt	

Insects on Field Tobacco - Foliar Treatments

Insect	Insecticide and Formulation	Rate per Acre	Remarks and Precautions
Japanese beetles	Carbaryl (Sevin) 80S	1 ¼ lb or 3 tbs per gal of water.	Apply as a spray.
	(Sevin) 50W	2 lb	
	(Sevin XLR Plus) 4F	1 qt	
	(Sevimol) 4F	1 qt	
	Imidacloprid (Provado) 1.6F	4 fl oz	
Stink bugs	(Thiodan/ Golden Leaf Tobacco Spray/ Phaser) 3EC	2/3 qt	Apply as a spray. **Do not apply Endosulfan after topping. Highly toxic.**
White fringed beetle	No chemical controls		Cultural control: Rotate tobacco with grass crops. Control legumes and broadleaf weeds. **Do not plant tobacco after legumes.**

SPECIAL PRECAUTIONS

1. Thiodan/Golden Leaf Tobacco Spray/Phaser is highly toxic to bees exposed to direct treatment or to residues on crops.
2. Sevin, Lannate, Orthene, and Thiodan/Golden Leaf Tobacco Spray/Phaser, are highly toxic to bees and should not be applied when bees are actively visiting the area.
3. Avoid excessive use of insecticides on tobacco. Do a thorough job of treating and repeat only when necessary.

HARVESTING AND CURING

James L. Jones, Extension Agronomist, Tobacco
T. David Reed, Extension Agronomist, Tobacco

Because of the differences in crops, growing conditions, weather prevailing during different stages of curing, and other factors, it is not possible to make detailed recommendations regarding this phase of dark-fired tobacco production. Many growers could greatly improve quality of dark-fired tobacco by adopting some of the curing procedures used by certain growers who consistently produce high-quality tobacco.

The following general suggestions are based on discussions with successful growers:

1. Cutting - Dark-fired tobacco should be harvested when the leaves are mature, but not overripe. Delaying harvest past the optimum stage of maturity will result in poor cured leaf quality. Tobacco will be less brittle and less breakage will result if cutting is delayed in the morning until after the dew has dried and the tobacco has become soft and pliable. With tobacco of average size, do not put more than 5 to 6 plants per stick. The important point is - don't let your tobacco be overcrowded in the barns because you put too many plants on the sticks.

2. Scaffolding - Scaffolding in the field is a good practice. In favorable weather, scaffold tobacco will be ready to hang in the barn in 2 days. By properly scaffolding, less bruising and breaking of the tobacco will result, and the work required in filling the barn will be greatly reduced because the moisture content will be reduced while the tobacco is on the scaffold. Also, the wilted tobacco will be lighter and easier to handle in the barn.

3. Filling the barn - Overcrowding in the curing barn is one of the biggest mistakes made by many growers. Under most conditions, sticks should be spaced 8" apart on the tier poles. Fill each room from top to bottom. Avoid putting green tobacco under partially cured tobacco.

4. Curing - The first few days after housing is known as the yellowing period. Relatively high humidity is required for this phase of the curing process. If the weather is cool and the barn is open, the sticks of tobacco are sometimes pushed up close together as they are put in the barn and allowed to yellow; they are spaced the proper distance for firing. Another way to create desired humidity for yellowing is to wet the barn floor with 2 or 3 barrels of water; to prevent run-off, trenches are dug in the floor of the barn. Some growers increase humidity by applying wet sawdust on the barn floor.

   Some growers complete the yellowing process with little or no firing. Others begin the yellowing stage by starting slow fires as soon as the barn is filled. During the yellowing period, it is important to have many smoldering fires rather than a few larger ones. Twenty-four small fires are recommended for a 6-room barn. These fires should be uniformly distributed throughout the barn. Avoid hot fires during the yellowing period. Such fires will kill the plants and result in a fixed green color. Many successful growers prefer to use oak or hickory wood that is dead or slightly green. Gum that has started to decay is also satisfactory.

   The next step in the curing process is to obtain and set the color. This is a most important phase in the curing process and requires much experience. During this period considerable humidity within the barn is

essential so that the plants may become "in order" or "soft". When the plants are "in order" the sap passes through the tissues and brings about uniformity of color. This is known as "running" or "sweating", and should not be allowed to continue too long at one time or the tobacco will houseburn or rot. To prevent houseburn, it is essential that temperature be held relatively high in relation to humidity, and that fires be run long enough to drive out the moisture but not long enough to dry the leaves. You can tell when to start the fires by the condition and odor of the leaves. Uncured tobacco in high "order" has an odor of decay, often referred to as a funky odor. Generally, the process of "running" and drying out the plants has to be done several times before the desired color is secured. During this curing stage if fires become too hot, wet sawdust can be sprinkled on them. This will smother the fires to the proper heat and at the same time, increase humidity.

When the leaf stem begins to turn yellow next to the stalk, and the desired color is set, the leaf and stalk drying process should begin. For this, some growers use relatively high temperatures, while others use slow fires to complete the curing. The amount of sap in the plants, weather conditions, the type of barn, and other factors may make it necessary to lengthen or shorten any of the stages of yellowing and curing.

5. Bulking - After tobacco is thoroughly cured, take down and bulk as much as possible. Bulking can be done on a raised platform in the barn. In most seasons tobacco will be ready to go in the bulk the first part of November. If tobacco is bulked when it is in proper order and covered with clean bags, it will keep without damaging for several months. Some advantages of bulking are:

   a. Color will improve and be more uniform.
   b. Bulking prevents a loss of weight, texture, and color, which occurs when tobacco is left hanging in the barn after curing is completed.
   c. Since tobacco will always be "in order" in the bulk, you can prepare it for the market any time.
   d. Marketing can be completed earlier.

Pole-Sweat or House-Burn

Pole-sweat, or house-burn, should be looked for during periods of prolonged wet weather, accompanied by rather high temperatures. It is caused by minute organisms, which attack those parts of the leaf that give it toughness and stiffness, causing it to soften and decay. House-burn does not occur until after the leaf tissue dies, but, of course, some parts of the leaf may die much sooner than others, so that the disease may appear before the entire leaf is dead. The organisms which cause this trouble are not active at very low temperatures, so that house-burn does not appear to any extent in cold weather. Furthermore, they thrive only in the presence of an abundance of moisture.

The three conditions necessary for the rapid spread of the disease are:

(1) tobacco which has passed through the first stage of the cure or which has been killed by bruising or other injury,

(2) a temperature ranging from 60° to 100° F, and

(3) a relative humidity of 90 percent or more, which checks the evaporation from the leaves, causing them to become soggy.

Conditions favorable to pole-sweat may exist for short periods without the appearance of the disease, but it will certainly develop if these conditions continue for 24 to 48 hours. The remedy for this trouble lies in controlling the humidity in the curing barn during periods of excessively damp weather.

PREPARATION FOR MARKET

Many dark-fired tobacco growers fail to get maximum returns for their tobacco because they are not doing a good job of preparing it for market.

Some of the more serious mistakes growers make are: leaving the crop hanging in the barn after it is cured, using excessive amounts of water in "ordering" tobacco, marketing mixed tobacco (leaf length and color).

Here are 5 reasons why good preparation-for-market practices will help you get more money for your crop:

1. The tobacco will look better when displayed on the floor.
2. It will be easier for the tobacco inspector to do a good job of grading.
3. It will be more easily evaluated by the buyers.
4. It will be worth more to the buyer because it will require less rehandling.
5. If it goes under the support price program, the price support will be higher than if the tobacco were poorly sorted and poorly handled.

Good lights - Be sure to have a comfortable and well-lighted place in which to work. Good lighting conditions are important. Use 4-tube, 40-watt fluorescent fixtures alternating "daylight" and "cool white deluxe" tubes. Fixtures should be placed end to end 4 feet above the top of the stripping table. Use a northern light if fluorescent lights are not available. When you work under a fluorescent light, the light is the same all the time; when daylight is used, the light changes continuously during the day.

Stripping - Although tobacco may have been properly bulked in natural order, it is necessary in some instances to apply a little water to the outside of the bulk to keep leaves from crushing. Any water used should be applied sparingly, and only as a fine mist under pressure. When stems become soft from too much moisture, tobacco is in danger of bruising or staining. Bruised or strained tobacco has little value. The desirable order for marketing is just enough moisture to make the leaf pliable. This will prevent breaking and staining and will improve the appearance on the warehouse floor.

The number of grades you need to make depends on the kind of crop you have produced. With most crops, it is desirable to make at least 3 grades.

In making your grade separations, be certain to keep these key points in mind:

1. Keep your colors separate and never mix green and off-colored leaves with other grades. Also, be sure to keep dark and brown leaves separated.
2. Keep leaves of different lengths separate. Best quality tobacco 22" long or longer is generally more valuable then tobacco less than 22" long.

It is generally necessary to make the following separations when sorting dark-fired tobacco:

1. Lugs - This group of leaves normally grows at the bottom of the stalk. They show a material amount of injury of the kind characteristic to leaves grown near the ground.

2. Thin Leaf - All grades in the C group must be clean, sound, of thin to medium body, and more than 16" long.

3. Heavy Leaf - All grades of the B group must be clean, sound, and of medium to heavy body.

4. Wrapper - This group consists of leaves from the Heavy Leaf and Thin Leaf groups. Cured leaves of the A group show a low percentage of injury. Wrappers are high in oil and elasticity.

Tying - When tying tobacco, make the heads 1" in diameter. This makes a desirable and attractive sized bundle. Bundles that are too large and bundles that vary in size create serious problems in redrying, and may result in the tobacco being damaged in the hogshead when packed for shipment.

Bulking Tied Tobacco - As the tobacco is tied in "hands", it should be put in a bulk until taken to market. Some growers of dark-fired tobacco place the hands on thin sticks and bulk it down. The tobacco is then hauled to market on sticks. Time required in handling the tobacco at the farm and at the warehouse is reduced when this procedure is followed. Do not use thick sticks because they will spread the bundle and cause drying of the head.

Transporting to Market - Tobacco should be placed on the truck in such a manner that the different grades can be kept separated so the mixing of grades will not occur when unloading at the market. Cover the tobacco to protect it from rain and dust, and to prevent it from drying on the truck and before the sale.

Baling of Dark-Fired Tobacco

The tying of dark-fired tobacco into hands and the subsequent rehandling or rebulking of this tobacco represesnts a considerable amount of labor and expense. Research in recent years (1990-91) to develop a loose-leaf package for Virginia dark-fired tobacco has shown that baling is an effective system and will significantly reduce the expense of market preparation. Marketing of dark-fired tobacco in bales was approved in Virginia for the 1992 marketing season. All grades of baled dark-fired tobacco, except first and second quality thin leaf (C) and heavy leaf (B), are eligible for full price support. Such high quality tobacco (wrappers) should continue to be tied in hands until users of this tobacco can handle the leaves in bales. Baling of wrappers will lower the support price to that of a comparable third quality grade and may reduce the price that a buyer is willing to pay. Growers would need to determine whether the expected price will cover the additional expense of tying this tobacco. Only bales that are properly constructed will receive an official grade and corresponding price support. Therefore, it is imperative that all specifications and directions for making bales be followed closely.

Bale Specifications

1. Size - 12" wide and a maximum of 18" high. Bale length may vary according to the size of the tobacco, but must be 36, 40, or 44" long. Bales of heavy bodied, upper stalk tobacco may be less than 18" high to remain below 60 pounds.

2. Bale Weight - 45 to 60 pounds per bale.

3. Bales are constructed with heads aligned flush with the outside edge of the bale and in alternating flakes. Tobacco must be in proper

keeping order, free of bruising, and not nested with inferior tobacco or foreign matter.

4. Bales must be tied with approved cotton twine. The proper twine is a large diameter, 100 percent cotton having a minimum tensile strength of 150 pounds. (A 2-lb and 5-lb spool has approximately 500 and 1200 feet of twine, respectively.) Strings must be tied with a knot that can be easily untied and retied following inspection of the bale.

In order for the tobacco to be properly worked in the processing plant, bales must be constructed with the leaves in alternating layers or "flakes" with tails overlapping 6 to 10 in. and heads flush on both ends of the bale. Growers are strongly encouraged to build 3-sided boxes (flake boxes), use them to sort leaves by grades, and to align heads and place a uniform amount of tobacco in each flake. Complete directions for baling dark-fired tobacco and construction plans for the baler are detailed in "Baling of Virginia Dark-Fired Tobacco", Virginia Coop. Ext. Publ. No. 436-420.

Consideration of leaf order (moisture content) is similar to tying leaves into hands. Tobacco that can be safely tied and stored will be suitable for baling. Baling of tobacco in high order will likely result in rotting of tobacco due to the pressure within the bale and the lack of air movement to dry tobacco. Bales should be stored by laying flat on their side and stacked three high and covered with burlap and an outer layer of plastic. Stacking bales off the floor on pallets or old bed springs will further reduce the likelihood of mold or rot.

Growers with questions regarding dark-fired tobacco baling should contact their county Extension agent or the tobacco Extension personnel at the Southern Piedmont Agricultural Research and Extension Center.

COMMONWEALTH of VIRGINIA

VIRGINIA DARK-FIRED TOBACCO BOARD

P. O. Box 129
Halifax, Virginia 24558

ANNUAL REPORT

JULY 1, 1996- JUNE 30, 1997

MISSION: To plan and conduct campaigns of education, advertising, publicity, sales promotion and research for the purpose of increasing the demand for and consumption of Virginia dark-fired tobacco.

COMPOSITION OF BOARD: The Board is composed of five members appointed by the Governor, who is guided in his appointments by recommendations of organizations representing dark-fired tobacco producers. The members represent, as nearly as possible, each important dark-fired tobacco producing section in Virginia.

FUNDING: Funds to support the programs of the Board come from an excise tax paid by all dark-fired tobacco producers. The excise tax levy is 20 cents per hundred pounds of tobacco sold. The excise tax levied is collected by dark-fired tobacco auction warehouses at the time the tobacco is sold by producers and is subsequently remitted to the Board by the warehouses. The Board is responsible for ensuring that the tax has been properly collected and remitted.

Board Programs:

A. Research

The Board funded two research projects on dark-fired tobacco which were conducted at the VPI & SU Southern Piedmont Agricultural Research and Extension Center.

B. Market Development

Funding was provided to cover part of the travel expenses incurred by a Virginia dark-fired tobacco delegation in visiting with buying companies in Kentucky and Tennessee for the purpose of promoting the sale of Virginia dark-fired tobacco.

C. Education

The Board funded the printing of a market update and baling brochure which was sent to all producers.

FINANCIAL STATEMENT

July 1, 1996 - June 30, 1997

Revenue:		
Cash Balance - July 1, 1996	$ 7,964.49	
Net Excise Tax Receipts	3,426.95	
Total		$ 11,391.14
Expenditures:		
Administration	$ 116.23	
Research	$ 2,587.16	
Market Development	$ 373.20	
Education	$ 257.65	
TOTAL		$ 3,334.24
Cash Balance - June 30, 1997		$ 8,056.90
Outstanding Obligations (For research, education and promotion projects to be conducted in 1997-98)		$ 6,550.00
Unobligated Balance - June 30, 1997		$ 1,506.90

****

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