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Burley Tobacco Production Guide

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AGRONOMIC INFORMATION

Danny R. Peek, Extension Specialist, Burley Tobacco
T. David Reed, 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. The best practice is to produce your own transplants. Doing so will reduce the likelihood of importing disease and pest problems onto your farm. The next best alternative is to buy transplants from someone in your local community. If you must import transplants, purchasing certified disease free transplants is strongly recommended.

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 plant bed area needed 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^{0}F or higher, preferably in the fall.

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. To avoid plant injury and possible loss of transplants 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. Beds covered with porous materials (Reemay, cotton, 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 1/2 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.

8. Control diseases and insects using only approved chemicals.

9. 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 1/2 inch above the bud of the largest plants.

The lack of sufficient water is perhaps the most frequent cause of inadequate plant bed stand and transplant shortage. Moisture is particularly necessary for seed germination and seedling establishment. Natural rainfall is often not adequate and must be supplemented with irrigation to ensure production of adequate transplants.

Deficiencies of sulfur or magnesium 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.

PLANT BED MECHANIZATION

Narrow-raised Plant Beds

A narrow (4 to 6 ft wide), raised plant bed has many advantages over the more traditional 5-yard wide bed. The narrow bed facilitates the use of tractor mounted equipment for spraying, clipping, and undercutting. In addition to reducing labor and increasing efficiency of transplant production, raised-narrow beds are better drained and easier to undercut than traditional beds. Raised beds, which are flat across the top, may be formed with a tilrovator or bedformer. Acceptable raised beds may also be formed by breaking the bed to the center with a turning plow and disking with the angle taken out of the back section of the disk.

Mechanical Seeding

Mechanical seeding that will insure a uniform rate of seed is becoming more popular in tobacco transplant production. Most precision seeded beds utilize pelleted or coated seed that can be metered for a specific seed spacing. Commercial seed companies are now marketing pelleted seed of most popular varieties. The Stanhay Precision planter has been used most frequently and has given good results.

Clipping Plants

Clipping (removal of a portion of the leaves above the bud) has been shown to increase uniformity among plants and increase the percentage of usable plants on a bed. Removal of leaves from larger plants permits light penetration to smaller plants allowing them to catch up and produce a higher percentage of desirable plants in one pulling. Clipping is also a good management tool to salvage overgrown plants or to hold back excessive growth of plants in the bed during adverse field conditions. Two clippings spaced 4 to 5 days apart can delay transplanting by 7 to 10 days.

Clipping can be accomplished with a modified high suction lawn mower or a tractor-mounted rotary mower with rear mounted gauge wheels. Tractor-mowed mowers work best on narrow (6 ft wide), raised plant beds, but can be

used on wide (15 ft) beds by running one set of wheels down the center of the bed.

Plants should be clipped when the largest plants reach a height of 4 inches; repeated clipping can be done 4 to 5 days apart. Care must be taken not to cut the buds off. The mower should be washed with a 1:1 solution of household bleach and water before and after each use to minimize the possible spread of virus diseases.

Plant Bed Undercutting

Undercutting, a new technique accomplished by pulling a blade just below the root system of transplants, can be used to reduce labor for pulling plants. Undercutting loosens the soil around plant roots and makes pulling easier and faster. Research conducted at N. C. State University by R. C. Long showed that pulling labor can be reduced by 50 to 60% on clipped beds with undercutting. Undercutting is most advantageous on beds with a high percentage of uniform, useable plants; therefore, plants should be clipped two or three times before undercutting. A narrow plant bed (4 to 6 ft wide) is suggested where undercutting will be used.

VARIETIES

Carol A. Wilkinson, Associate Professor, Agronomy

Variety selection is a very important step in the successful production of burley tobacco. Individual farmers have different requirements for the variety or varieties grown on his/her farm. Requirements for disease resistance, yield potential, ease of growing and curing, and market acceptance should be considered when selecting a variety.

Three new varieties were commercially available for the 2001 growing season. KT 200, NC 4, and HB 04P met the chemical and physical standards in the 1997, 1998, and 1999 Regional Variety Evaluation Program, respectively. One new variety, NC 5, is available for the 2002 growing season. Growers are advised to plant only a limited acreage of any new variety until more information and experience is available from a wider range of soil and climatic conditions.

KT 200 (tested as GR 171) was released jointly by the University of Kentucky and University of Tennessee. It is a late maturing hybrid with moderately high yield potential. KT 200 is moderately resistant to black shank and is recommended for growers with serious black shank problems. It has a high level of resistance to black root rot. KT 200 is resistant to tobacco mosaic virus, wildfire, and the virus complex (potato virus Y, tobacco etch virus, and tobacco vein mottling virus). It is darker green than most other varieties, holds well at the bottom of the plant, and occasionally sunburns during curing.

NC 4 (tested as NC 9810) and **NC 5** (tested as NC 9806) are developed by North Carolina State University. Both are moderately yielding hybrids with resistance to tobacco mosaic virus, the virus complex, wildfire, and root knot nematode. NC 4 has a high level of resistance to fusarium wilt and black root rot and a low level of resistance to black shank. NC 5 has a high level of resistance to race 0 black shank and a low to moderate level of resistance to race 1 black shank. Seed will be available from F. W. Rickard Seed Company.

HB 04P (tested as B 04P) was developed by F. W. Rickard Seed Company. It has excellent yield and quality potential. HB 04P has broad round leaves, a semi-upright growth habit, and medium maturity. It is resistant to tobacco mosaic virus and wildfire. HB 04P has a high level of resistance to black root rot. It is susceptible to black shank and the virus complex.

Agronomic information, disease resistance rating, and other characteristics of varieties tested at the Southwest Virginia Agricultural Research and Extension Center in 2001 are shown in Table 1 (page 5) and Table 2 (page 6). For more detailed information on varieties refer to publication 436-417 (Revised 2002) "Burley Tobacco Variety Information for 2002".

Table 1. Yield, Value Indices, Agronomic, and Disease Information for Released Varieties Tested at Southwest Virginia Agricultural Research and Extension Center, Glade Spring, VA, 2001.[1]

Cultivar	Yield (lbs/A)	Value ($/A)	Price ($/cwt)	Grade index[1]	Plant height (inches)	Leaf no.	Days to Flower	Mid Leaf L --(inches)--	Mid Leaf W --(inches)--	Disease Reaction[2] BS	BRR	TMV	WF
KY 14	2775	4417	159	48	53.0	22.8	62	31.0	12.3	S	M	H	H
KY 907[3]	2881	4219	146	40	55.1	23.5	67	28.7	13.6	L	H	H	H
KY 910[3]	2433	4348	179	61	53.4	19.3	62	29.9	12.9	[4]	H	H	H
NC 2000	2946	4546	155	36	49.0	23.2	73	27.4	11.3	S	S	H	H
TN 90[3]	2764	4511	162	48	50.5	20.9	65	28.1	11.9	M	H	H	H
TN 97[3]	2937	5148	175	55	51.7	21.6	64	28.2	12.0	M	H	H	H
Bu 21 x KY 10	3084	5786	188	62	54.7	22.1	63	29.4	12.4	S	L	H	H
HB04P	2639	4713	178	57	55.8	21.0	61	30.3	13.4	S	H	H	H
KY 14 x L 8	2638	4927	187	64	49.5	18.9	59	30.6	13.1	[5]	M	H	H
KT 200[3]	3057	4605	151	44	53.8	22.9	67	28.9	12.5	L	H	H	H
NC 4	2854	4959	174	55	54.3	21.5	65	28.7	12.5	L	H	H	H
NC 5	2706	4287	157	48	53.8	21.3	66	30.5	13.6	[4]	H	H	H
NC BH129	2799	4958	177	55	57.1	20.7	64	30.1	13.1	S	H	H	H
Clay's 403	3117	5348	172	57	52.7	21.9	69	29.8	13.0	S	M	H	H
PF 561	2617	4407	168	54	52.8	20.3	62	29.3	12.2	M	H	H	H
R 630[3]	2730	4659	170	57	56.4	21.4	64	28.6	12.7	M	H	H	H
R 711	3078	4351	142	36	52.3	20.9	67	30.2	12.5	S	M	H	H
R 712	2849	4650	163	48	55.3	21.3	63	30.1	12.7	S	H	H	H

[1] Grade index is a numerical quality rating based on government grade. High ratings are best.

[2] BS = black shank; BRR = black root rot; TMV = tobacco mosaic virus; and WF = wildfire. Resistance levels: H = high; M = moderate; L = low; S = susceptible, and – not determined.

[3] High resistance to tobacco vein mottling and medium resistance to tobacco etch virus.

[4] High resistance to race 0 and medium resistance to race 1.

[5] High resistance to race 0 and no resistance to race 1.

Table 2. Color and group grade data for released varieties tested at the Southwest Virginia Agricultural Research and Extension Center, Glade Spring, VA, 2001.

	Color Grade [1](%)						Group Grades [2](%)			
Cultivar	L	F	FR	K	M	VF	X	C	B	T
KY 14	0	20	0	64	16	0	0	28	66	6
KY 907	0	14	0	86	0	0	0	21	74	5
KY 910	0	75	0	25	0	0	0	22	65	13
NC 2000	0	0	0	74	0	26	0	24	63	13
TN 90	0	38	0	62	0	0	0	28	67	5
TN 97	0	41	0	39	20	0	8	17	71	4
Bu 21 x KY 10	0	48	0	6	27	19	0	28	66	6
HB04P	0	38	0	34	28	0	0	28	61	11
KY 14 x L 8	0	88	0	12	0	0	10	20	65	5
KT 200	8	0	0	82	10	0	0	28	62	10
NC 4	0	36	0	39	20	5	0	25	75	0
NC 5	0	28	0	72	0	0	0	24	65	11
NC BH129	0	36	0	33	26	5	0	25	63	12
Clay's 403	0	56	0	44	0	0	0	27	69	4
PF 561	9	43	0	48	0	0	9	17	68	6
R 630	0	56	0	44	0	0	0	26	62	12
R 711	0	0	0	100	0	0	0	30	65	5
R 712	0	9	0	58	28	5	0	30	64	6

[1] L = buff; F = tan; FR = tannish red; K = variegated; M = mixed; VF = greenish tan.

[2] X = flyings; C = lugs; B = leaf; T = tips.

TRANSPLANTING AND SPACING

The time of transplanting is largely dependent upon when the plants reach transplant size. It is good to plan to have the plants ready for transplanting about May 15. Early transplanting, before June 1, is preferred to a later planting because moisture conditions for quick, early growth are usually better. Good stocky plants with a healthy root system are most essential to obtaining a full stand without replanting. Plants 8" to 10" in length with stems of about the diameter of a pencil live better and grow more rapidly than the smaller or larger plants.

The use of a properly adjusted mechanical setter is highly desirable and results in a stand with better early growth than a hand-set stand. Replanting of missing plants is usually not an economical practice if the original stand is 90% or more. With a limit on the pounds of burley which can be marketed, growers should strive for efficiency and lower cost of production to increase their income. Under the poundage control program, growers are now permitted certain practices which were either not feasible or not permitted under the program of acreage control.

Some suggestions which may be helpful are:

1. At transplanting, plan for a 95% or better stand without replanting by setting only strong stocky plants about eight inches long (from ground to bud) and using sufficient water at time of planting.
2. Use a wider spacing. Space plants 18 to 24 inches apart. This will result in more weight per plant so that fewer plants will need to be handled at setting, harvesting, and stripping. The acreage used will need to be slightly larger than that used previously.
3. Plant eight to ten rows and skip one so that a tractor sprayer may be used to apply any needed insecticides and the sucker control chemical. This will also facilitate harvesting operations by permitting easier dispersal of sticks before cutting and more convenient pick-up of tobacco when housing.

SPACING CHART - PLANTS PER ACRE

Row	Spacing in Rows (Inches)				
Width (Inches)	16	18	20	22	24
42	9334	8297	7467	6788	6222
44	8912	7920	7128	6480	5940
46	8523	7576	6818	6198	5682
48	8167	7260	6534	5940	5445

EFFECT OF SPACING

Yields and values of burley tobacco (from three fertility treatments with two plant spacings) at the Southwest Virginia Research and Extension Center:

Treatments[1]	Plant Spacing	Yield lb/acre	Value $/Cwt	Value $/acre
150-200-300	18"	2662	117.39	3125
	24"	2598	117.51	3053
200-200-300	18"	2634	117.08	3084
	24"	2553	117.66	3004
150-200-475	18"	2749	117.35	3226
	24"	2573	117.41	3021
Average of	18"	2682	117.26	3145
Average of	24"	2575	117.51	3026

[1] Pounds per acre of nitrogen, phosphorus, and potassium.

Percent of tobacco by quality, group, and color (as affected by three fertility treatments with two plant spacings) at the Southwest Virginia Research Station:

		Percent by weight		
Treatments[1]	Plant spacing	Quality 1,2,3	X & C group	Poor color
150-200-300	18"	85	61	3
	24"	83	43	2
200-200-300	18"	83	45	2
	24"	81	43	0
150-200-475	18"	83	60	7
	24"	85	57	2

[1] Pounds per acre of nitrogen, phosphorus, and potassium.

The 18" spacing produced a higher acre yield than the 24" spacing at each fertility level, with an average 4.15% increase for the closer spacing. The 18" spacing requires 2075 more plants to be produced, transplanted, harvested, housed, and stripped. As an average of the three fertility levels, plants at the 18" spacing returned $37.90 per 100 plants, while plants at the 24" spacing returned $48.63 per 100 plants or 28.31% more per plant.

There was a slight trend for tobacco from the 24" spacing to be a little better in value. There was little or no difference in the percentage of quality tobacco produced from the two spacings, but there was a slight trend for the tobacco from the wider spacing to be heavier in body. Tobacco produced from the 24" spacing was slightly better in color.

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 burley tobacco production, fertilization practices are among the more important. Fertilizer requirements for burley 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 (5.8 - 6.2) and to supply needed calcium and magnesium. The Soil Testing Laboratory at Virginia Tech will run a soil test, for in-state commercial farmers, at no charge; $3.00 for organic matter and $3.00 for soluble salts. Soil testing is also available through commercial laboratories and farm supply dealers. 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 nitrogen (N), phosphorus (P_2O_5) and potassium (K_2O).

Soil Test Level	Fertilizer Recommendations (lb/A)		
	N	P_2O_5	K_2O
L	175-200	290-330	250-350
M	175-200	60-100	200-250
H	175-200	40	100-200
VH	175-200	40	100

Nitrogen usually affects the yield and cured leaf quality of burley 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 175 to 200 pounds of nitrogen per acre are necessary to produce high yields of good quality burley tobacco.

The total amount of nitrogen supplied may come from commercial fertilizer, manure, legumes, and other crop residues. Dairy manure will normally supply about 5 lbs of available nitrogen per ton. However, dairy manure should not be applied in excess of 10 tons per acre because of chlorine and soluble salts. Nitrogen can be lost easily by leaching from sandy soils.

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 probably affects the quality or usefulness of the cured leaf more so than any other element. Potassium is necessary not only for growth, but it also enhances the burning quality of the tobacco. Potassium promotes the spread or width of the leaves and makes them light bodied. A deficiency of this element will be noticeable in the growing plant at the leaf tips and margins which have a bronze yellow appearance and tend to turn down or curl under. The tips of the leaves may deteriorate and fall off in the field, giving the tobacco a ragged appearance. Tobacco deficient in potassium is more subject to leaf diseases such as wildfire and brown spot.

The amount of potassium to apply for the burley crop may vary from about 100 lbs. per acre of K_2O for soils testing in the upper high range of availability to 300 or more for soils testing in the low range.

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 (0-0-50). Or potassium nitrate (13-0-44). *Don't use muriate of potash* (0-0-60). No more than 30 pounds of chlorine per acre should be applied to burley tobacco.

Selecting the Fertilizer Grade

Once the amount of N, P_2O_5, and K_2O requirements has been determined, one should consider the options available to supply the required nutrients at the most economical prices. The following table gives some of the available fertilizers blended for burley.

Nutrients Contained In:

	Amount	lbs/A		
Analysis	lbs	N	P_2O_5	K_2O
5-10-15	1000	50	100	150
8-16-24	1000	80	160	240
10-6-18	1000	100	60	180
34-0-0	100	34	0	0
16-0-0	100	16	0	0
15-0-14	100	15	0	14
13-0-44	100	13	0	44

The analysis of a fertilizer gives the percentage of nitrogen, phosphorus (P_2O_5), and potassium (K_2O) contained in the material. The analysis determines the amount of nutrients supplied. For example, a 5-10-15 supplies 5 pounds of nitrogen, 10 pounds of phosphorus (P_2O_5) and 15 pounds of potassium (K_2O) for each 100 pounds of fertilizer. Custom blended fertilizer materials are available in most areas and can be used to meet fertility needs more effectively. By shopping for the best price, a less costly fertilizer program can be obtained.

Transplant Starter Solutions

The use of soluble fertilizer materials in the transplant water has historically resulted in reductions in plant stand and stunted growth. The probability of such an effect is great enough to discourage the use of starter solutions. If any benefit is to be expected from their use, it would be the ready availability of phosphorus to the transplant when soil availability may be lacking. This would be most important in years with a cool, wet spring. In recent years, new materials with relatively high phosphorus levels have become available. In 1993, a study was conducted to evaluate five of the many products available. The test evaluated starter fertilizers using both plant bed and greenhouse-grown transplants. Treatments tested included:

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

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

Measurement of plants in the field indicated that Trts. 3-6 (high P) resulted in more rapid early season growth than observed with the low P fertilizer (Trt.2) or untreated plants (Trt 1). As plants neared topping stage, differences between the treatments tended to diminish. However, plants in Trts 3-6 did come into top earlier than those in Trts 1 and 2. There was no apparent difference in the response of plant bed and greenhouse-grown transplants to the fertilizers. Research conducted previously has shown the benefit of available P on early season growth; however, no benefit has been observed in the final yield of the crop. Such was the case with this study also. There was no significant difference in the yield of any of the treatments for both plant bed and greenhouse transplants, regardless of early-season growth effects observed (see Table 7).

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

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

GH = greenhouse and PB = plant bed grown transplants

Liming

A liming program, based on a soil test, should be a part of the overall management program for burley tobacco production. According to a summary of soil analyses from the Virginia Tech Soil Testing Laboratory, approximately 31% of the tobacco fields in Virginia need liming. 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 from fertilizers.

The desirable pH range for burley tobacco in Southwest Virginia is 5.8 to 6.2. Applying dolomitic lime when needed will lower soil acidity (raise pH) and reduce the exchangeable aluminum, which can be toxic to plants. Increasing the soil pH will also reduce the available manganese contained in our soils. The efficiency of plant uptake and use of phosphorus and other nutrients is increased when soils are properly limed. Since limestone contains magnesium and/or calcium these nutrients are increased as lime is applied. Approximate amounts of limestone to attain a pH of 6.2 (on unlimed sandy, loamy, and clayey soils) are shown in the following table:

Approximate Amounts of Limestone to Attain a Desired pH of 6.2.

pH of Unlimed Soils	Soil Type		
	Sandy	Loamy	Clayey
	--------Lime, Tons/Acre--------		
5.0	2.50	3.25	3.75
5.4	1.50	2.0	2.5
5.8	0.75	1.00	1.25

Lime is never suggested for burley 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 5.2 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.

Secondary Elements and Micronutrients

In addition to nitrogen, phosphorus, and potassium, burley tobacco requires sulfur, calcium, and magnesium to produce normal growth.

Sulfur is amply supplied to tobacco as a naturally-occurring element in the soil, as a constituent of rain water, and as a chemical compound used in the preparation of fertilizers.

Land which has recently been limed to reduce soil acidity and has a pH between 5.5 and 6.0 should contain sufficient calcium for burley tobacco. It is not necessary to supply additional calcium in the form of fertilizer.

Since most tobacco fertilizers contain magnesium and nearly all ground limestone contains some magnesium, this element will usually be supplied in adequate amounts through the normal fertilizing and liming practices.

Other elements needed in very minute amounts are boron, zinc, manganese, copper, iron, molybdenum, and chlorine. The soil types on which burley is produced contain these elements to some degree, and the recommended pH level favors their availability to the plant. Also, fertilizers contain varying quantities of these elements. There is no evidence to indicate that the application of micronutrients should become a general practice in the fertilization of burley tobacco at this time.

Method of Application

On a fertile soil, it makes little difference whether subsequent fertilizer applications are plowed under or broadcast and disked-in after plowing. Row applications in excess of 500 pounds per acre of high-analysis mixed fertilizer should not be used because of the danger of root injury.

Sidedressing burley tobacco is not generally recommended. However, sidedressing will be beneficial when nitrogen or potassium deficiency symptoms appear early in the season because of excessive rainfall or lack of fertilization before planting. Use about 50 pounds of nitrogen and/or 100 pounds of potash per acre, incorporated into the soil by cultivation.

Foliar Fertilization

Using water-soluble fertilizers as a foliar application has not been proven to increase yields. Research from the University of Kentucky showed no advantage other than greening the crop up.

TOPPING AND SUCKER CONTROL

Topping

Research has shown burley tobacco to benefit from early topping, before the development of the full flower stage. Allowing a crop to reach full flower throughout an entire field before topping results in reduced yield of a lower quality tobacco, more difficult sucker control, increased likelihood of plants blowing over in the wind, and decreased drought tolerance. Suckers greater than one inch long should be removed at topping.

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. Maleic hydrazide should be applied as a course spray to the upper 1/3 of the plant.

3. The local systemic (Prime+ & Butralin) 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 PROGRAMS

The following topping and sucker control programs may be followed:

Program I. Early Topping with Contact and Systemic Chemicals

1. Apply a contact sucker at a 4% concentration (2 gal. in 48 gal. of water or 5 oz. in 1 gal. of water) when plants reach the button stage.

2. A labeled rate of MH should be applied one week later. Alternatives to MH alone include:

    - A tank mix of Prime+ at 2 qts/A with 1 to 2 gal./A of MH or 4 fluid ounces of Prime+ and 16 fluid ounces of MH in 3 gal of water.

    - FST-7 alone at 3 gal/A or tank mixed with Prime+ (FST-7 is a commercial product combining MH with contact fatty alcohol).

Program II. Late Topping with MH Alone

Apply a labeled rate of MH when plants are in the elongated button to full flower stage. Remove all suckers greater than one inch long. Alternatives to MH alone include:

- A tank mix of Prime+ at 2 qts/A with 1 to 2 gal./A of MH
- FST-7 alone at 3 gal/A or tank mixed with Prime+ (FST-7 is a commercial product combining MH with contact fatty alcohol).

Program III. Prime+ Individual Plant Method

Apply Prime+ with a dropline, backpack, 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. **Growers are reminded to comply with all label directions regarding worker protection standards (WPS).**

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.

Precautions with local systemics:

1. Rain occurring within 2 hours after spraying may reduce effectiveness.
2. Applications to leaning plants, wet plants, or wilted plants may reduce effectiveness.
3. Applications made before the elongated button stage of growth may result in chemical topping or distortion of leaves that were too immature at time of application.
4. 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. Recent research by Seltmann in North Carolina showed that if a significant rain occurs more than three hours after application, only a half rate of MH should be reapplied to maintain good sucker control.

Butralin

Butralin is a local systemic material, similar to Prime+ in chemistry and use. The current label allows butralin to be applied with boom type sprayer,

knapsack, or jug application. Butralin should be mixed at 1.7 fluid oz. per gallon of water. One gallon of the mixture should treat approximately 200 plants. Larger quantities may be mixed with 2 qts. of butralin in 35 gal. of water. Butalin may be used alone or in combination with MH-30 or other maleic hydrazide containing products. According to label, if tank mixed with MH-30 the mixture should contain 1.5 – 2.0 gal of MH-30 and 2 quarts of butralin in 50 gallons of water per acre. Applied alone, butralin should be applied at a rate of 2 to 3 quarts in 50 gallons of water per acre. If tank mixing butralin and MH-30 for knapsack sprayer use 4 fluid ounces of butralin and 12 fluid ounces of MH-30 in 3 gallons of water. No matter which application method is used apply as a course spray that provides adequate contact with each leaf axil.

Stifle

Stifle was first registered for use in burley tobacco in 1998. Stifle is a prepackaged combination of butralin and maleic hydrazide. One gallon of stifle contains the same amount of maleic hydrazide as one gallon of MH-30 and approximately 38% as much butralin as one gallon of butralin. There is no difference in application method than the tank mix of butralin and MH-30(must run down the stalk). According to the label stifle should be applied at the rate of 1.5 to 2.0 gallon in 50 gallons of water. For use in a knapsack sprayer mix 12 fluid ounces in 3 gallons of water.

EPA WORKER PROTECTION STANDARDS

Read and follow all label directions regarding EPA Worker Protection Standards (WPS). Proposed WPS rules will have a dramatic impact on how Virginia growers apply sucker control chemicals. Required personal protective equipment (PPE) and restricted-entry intervals (REI) following application will make hand application of Prime+ and contacts impractical. Hand topping following contact application provides the best level of sucker control, since the top serves to funnel the material down the stalk to contact each leaf axil. However, topping within the restricted-entry interval will necessitate workers to wear all required personal protective equipment to comply with WPS. Growers are also responsible for instruction of early-entry workers on how to prevent, recognize, and give correct first aid for heat illness (too much heat stress).

ATTENTION!

Precautions

1. **RINSE OUT ALL SPRAY EQUIPMENT BEFORE USING IT WITH ANY SUCKER CONTROL MATERIAL.**
2. **Observe all restrictions and precautions on pesticide labels.**
3. **Store all pesticides behind locked doors, in original containers with labels intact.**
4. **Use pesticides at correct dosages and intervals to avoid excessive residues and injury to plants and animals.**
5. **Apply pesticides carefully to avoid drift.**

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 wk 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.	Hand Application 20 psi max. and 1/2 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)
Prime+	1. Individual plants at elongated button stage (droplines or jug application) 2. 7-10 days after 1st contact application	When leaves are dry	2% solution or 1 gal in 49 gal of water (2.5 fl oz of Prime+ per gal of water)	coarse spray (20 psi and TG-3 or 5 nozzle) or drench using jugs and apply 1/2 fl oz per plant.
Systemics (MH)	When used as part of sequential control program - apply 7 to 10 days after last contact application.	In morning, after leaf surfaces are dry. Do not apply during the middle of hot days (plants wilted).	1 1/8 to 2 1/4 lb of MH (3/4 to 1 1/2 gal of 1.5 lb/gal product) (1/2 to 1 gal of 2.25 lb/gal product) Apply 40 to 50 gal of spray material per acre.	40 to 60 psi using 3 hollow cone nozzles per row (i.e. TX-18) Direct spray toward upper third of the plant.

GREENHOUSE TRANSPLANT PRODUCTION

Danny R. Peek, Extension Specialist, Burley Tobacco
T. David Reed, Extension Agronomist, Tobacco

Greenhouse transplant production has become a popular alternative to producing tobacco transplants in plant beds. Three of the most often cited advantages of greenhouse transplant production include: reduced labor required for transplant production, greater control of environmental conditions, and increased uniformity of transplants resulting in a more even growing crop in the field. Greenhouse culture does require increased capital investment in transplant production compared to plant beds. Furthermore, the production of plants in a soilless growing medium using hydroponic (float) techniques requires attention to new aspects of plant production. Finally, greenhouse producers have limited pest control options available, while the potential for serious disease problems is greatly increased with greenhouse transplant production.

Spiral Roots incidence is a significant problem in many tobacco transplant greenhouses. A spiral root seedling occurs when the root tip of the germinating seedling is damaged and grows aerially or on top of the media and not down into the media. Often the seedling develops a secondary root that grows into the media and the seedling will survive. However, in most cases the seedling's growth is delayed and will usually not result in a useable transplant.

The specific cause of spiral root seedlings is not fully understood. Early research indicated that inadequate media aeration (too little air, too much moisture) played an important role in spiral root seedling occurrence. This has largely been remedied by growers through better attention to tray fling and not over packing media in trays. Differences may occur between different brands of media, but these incidences usually result from quality control problems associated with specific batches of media rather than a consistent problem with a specific brand.

Recent research has suggested a greater association between pelleted tobacco seed and spiral root occurrence. The incidence of spiral root is dramatically decreased with the use of unpelleted seed. However, using unpelleted seed is not practical due to the fact that it's significantly slower and virtually impossible to determine if a seed is placed in each cell of the tray. The basic properties of the seed that impact seed vigor play an important role and this is further impacted by the nature of the pellet and how well it separates with the emerging seedling on the media surface. This is a problem when the breakdown of the seed pellet is less than desired. This situation is further complicated by differing wetting properties of the various brands of media and their impact on breaking apart the seed pellet.

As described above, much of the causes of spiral root seedling may be largely out of the hands of the grower. Growers cannot alter the properties of the seed and or pellet. Growers should not try to alter the properties of a growing media but rather avoid using a media that is either too dry or too wet. Growers should be mindful of the environmental conditions of their greenhouse. A thermometer, placed at tray level, should be used as an indicator of temperature and not the thermostat controls. Optimum temperature is 72°F. Although it's not practical to expect this temperature to remain constant throughout the germination process the least amount of fluctuation should result in the fewest spiral root seedlings.

Seed Covering to Reduce Spiral Roots. Recent research has evaluated the practice of covering seeds to reduce or eliminate spiral root seedlings. The purpose of covering the seed is to provide more consistent wetting of the seed pellet. Research conducted at Virginia Tech and NCSU has shown that covering with growing medium and Vermiculite is very effective in reducing spiral roots. However, even distribution of small amounts of these materials is difficult. Uneven covering or excessive covering of the seed can result in decreased uniformity of seedling emergence and may result in reduced plant stand. Recently, a commercial product has been tested as a seed covering material with results similar to that of covering with growing medium. One advantage of this new product is that it lends itself to automated application procedures. However, use rates are relatively low and excessive rates could be detrimental to plant stand. Thus, a calibrated applicator is necessary.

At the present time, covering tobacco seed is not recommended as a standard practice. Growers that have significant problems with spiral root seedlings may want to cover a few trays to evaluate this practice for their operation. Since covering seed could delay seedling emergence by 1-3 days growers should delay fertilization 1-3 days after seeding to reduce the chance of salts injury. Additionally, extension agents will have research results from test conducted in 2001 and may offer growers the opportunity to visit on-farm seed trials.

GREENHOUSE MANAGEMENT PRACTICES

Greenhouse production of tobacco transplants involves a much greater level of supervision and management than required with a plant bed. The following is a brief description of the important management practices required for successful production.

1. Sanitation

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

2. Ventilation and Air Circulation

Ventilation is necessary to remove moisture that naturally accumulates inside the greenhouse and to prevent high temperatures. Air circulation within the greenhouse is beneficial to reduce temperature stratification, reduce condensation on the greenhouse cover, remove moisture from the plant canopy (drier foliage), and evenly distribute greenhouse gases. The most common style of greenhouse used for tobacco transplant production utilizes side curtains that provide ventilation for cooling and allows fresh air exchange which is critical for reducing condensation within the greenhouse. The use of horizontal air flow (HAF) or a polytube system is highly recommended to provide increased air circulation.

3. Temperature Control

The most demanding period for heating is during the germination of the seed. Until maximum germination is obtained, the minimum temperature should be maintained at 72^{o}F. Extended periods of cooler temperatures will delay germination and decrease uniformity in the size of the seedlings. After germination, the minimum temperature may be reduced to 55^{o}F. Preventing high temperatures is equally as important as providing necessary heat for a greenhouse. Young seedlings are particularly sensitive and the temperature should be kept below 95^{o}F during the 2- to 4-leaf stage. As seedlings grow they are better able to withstand increasingly higher temperature; although, to reduce stress on the seedlings, the temperature should not be allowed to exceed 110^{o}F. High temperatures place greater stress on the tobacco seedlings due to increased water usage and concentration of fertilizer salts within the growing medium.

Primed tobacco seed is specialty processed seed that is "pregerminated" under controlled conditions and then pelleted. The use of primed seed will reduce the heating requirement and is recommended for use especially in outdoor float beds. The germination rate of primed seed at 60^{0} F will be similar to unprimed seed at 70^{0} F. However, the final germination percentage will usually not differ between primed and unprimed seed of the same variety.

Greenhouse temperatures should be measured at plant level to more accurately measure conditions impacting the seedlings. The use of a recording thermometer to measure daily high and low temperatures is an excellent management practice.

4. Media And Tray Filling

Media and tray filling may be the source of the greatest number of problems for Virginia greenhouse tobacco producers in recent years. Dry cells and spiral roots are each related to media handling and the tray filling operation. Assuring that all cells within a tray are uniformly

filled and that all trays are similar will improve the uniformity in seed germination and seedling growth. Cells must be completed filled for their entire depth to wick properly and prevent dry cells; but, overpacking of the cells must be avoided to prevent the occurrence of spiral root plants. Proper media moisture content is critical for adequate tray filling and the use of a premoistened medium is highly recommended. However, excessive moist media should be avoid since better plant stands are generally obtained with a media having a dry consistency rather than a media with more moisture and therefore a heavier consistency. Media should have only enough moisture to keep it from falling through the trays before floating. If trays wick properly, watering over the top should not be necessary to assist with seed germination. However, if trays are watered, only a fine mist should be used to prevent packing and waterlogging of the media.

5. Fertilization

Fertilizers used in float greenhouse transplant production are formulated to function with a soilless growing medium. Such fertilizers should contain at least 50 percent of their nitrogen as nitrate and should contain minimal urea which may injure young seedlings under certain conditions. Also important to proper fertilization is an accurate estimation of fertilizer solution concentration. In addition to using the correct fertilizer material, proper fertilization requires an accurate estimation of fertilizer solution concentration to ensure that seedlings are not injured by excessive fertilizer salts. The amount of fertilizer necessary for a float bay is determined by the volume of water in a bay, the fertilizer analysis, and the desired nutrient level of the float bay. Additional information on fertilization is presented on pages 20 and 21.

6. Water Quality

Water quality is a critical factor to consider with greenhouse production. Although water sources across the flue-cured tobacco producing area of Virginia pose little difficulty for most growers, sporadic instances of water quality problems have occurred for some growers. The only means of predicting such problems is through water testing and interpreting the results for plant production rather than as drinking water.

7. Clipping

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

the size of the field-ready transplant. Very early clipping (1.5 inches to bud or less) resulted in shorter than desired transplants.

Suggested Clipping Program

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

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

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

Float Fertilization Programs

Three different fertilization programs are suggested for float greenhouse tobacco production, depending on management level.

	Program	
Fertilizer Addition	**I**	**II**
	--- ppm N ---	
at seeding	100	0
2 weeks after seeding	--	100
4 weeks after seeding or at 1st clipping	100	100

Under normal circumstances no additional fertilizer should be necessary beyond the total of 200 ppm N. However, if the greenhouse is seeded too early and the production season is extended or if transplanting is delayed, a late season addition of fertilizer (75 to 100 ppm N) may be necessary to maintain adequate seedling nutrient levels.

Program I is the preferred fertilization schedule. This program provides a higher initial fertilization level (100 ppm N) at seeding. Research conducted at the Southern Piedmont AREC for two years and in grower greenhouses in 1995 and 96 indicate that this fertilization schedule provides quicker growth

of seedlings as compared to fertilization schedules which utilize low initial fertilization levels (50 ppm N) or no fertilizer provided at seeding. There were no differences in plant stand, spiral roots, or the amount of algae growth on the media. Seeding date may be delayed at least one week with Program I as compared to Program II.

Program II provides seedlings with a reduced fertilizer level at seeding, thus decreasing the potential for salt injury due to over-fertilization. However, such injury observed in Virginia is generally the result of errors in fertilizer addition, poor media quality, or improper fertilizer materials.

Comparative trials with fertilizer rates ranging from 0 to 250 ppm N indicate that algae growth will occur at any level of fertilization (50 ppm N and greater). Withholding any fertilizer until 1 or 2 weeks after seeding will reduce algae growth at the expense of slower seedling growth.

Program III is to be used in greenhouses equipped with fertilizer injectors. Fertilizer injectors are used to add water containing a specified nutrient level to float bays. A concentrated fertilizer solution contained in a stock tank is diluted with the injector to obtain the desired nutrient level. The suggested fertilization program using an injector is to add 125 ppm N to the bays each time water is needed (including the original filling). Actual nutrient levels present in the float bays should be monitored to insure that adequate fertility is maintained. Research conducted on-farm in grower greenhouses in Virginia have shown that nutrients are taken up by the plants at a greater rate than water and fertility levels reached very low levels in some instances.

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:

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

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 **or** 20-9-20	3.3	5.0	6.7	8.3	10.0	13.3
17-5-24	3.9	5.9	7.8	9.8	11.7	15.6
17-5-24 **and** 15-0-15[a]	2.6 **and** 1.5	3.9 **and** 2.2	5.2 **and** 2.9	6.6 **and** 3.7	7.8 **and** 4.4	10.5 **and** 5.9
16-4-16 **or** 16-5-16	4.2	6.2	8.3	10.4	12.5	16.6
15-5-15 **or** 15-4-15	4.3	6.7	8.9	11.1	13.3	17.7

[a]Fertilization program with 2 parts 17-5-24 and 1 part 15-0-15.

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.

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.

Tray selection will influence both the productivity and management of a greenhouse. The different Styrofoam float trays used for tobacco production are the same size but differ in the number of cells or plants per tray (see Table 2). The advantage of high cell count trays is the increased productivity of a given size greenhouse. For example, 44 percent more transplants could be grown using 288 cell floats instead of 200 cell floats. However, the level of management is greater with the higher density float trays. Both root volume

and stem diameter decrease with increasing cell number; and therefore, greater clipping frequency will be required to ensure adequate stem size. In addition, the increased crowding of the seedlings necessitates more critical ventilation and moisture reduction within the greenhouse to prevent environmental conditions that favor the development of disease.

Table 2. Float trays commonly used for greenhouse tobacco production.

Cells per tray	Vol. per cell (cc)	Plants per sq. ft.
200	27.0	80
242	23.5	97
253	16.0	101
288	17.0	115
338	8.6-11.2	135
392	13.6	157

Research conducted in Virginia to evaluate the impact of float cell number on transplant size and growth in the field. Stem diameter and plant size of 200 and 288 cell transplants were similar. Transplants from 338 cell trays, and to a greater extent 392's, were significantly smaller than those from 288 or fewer cell trays. However, there were no differences in plant stand, early-season growth, and yield of plants from any of the float trays tested.

The biggest difference between the float cell numbers is the cost per transplant. The larger transplants from a 200 cell float cost more to produce since fewer can be grown per square foot of greenhouse. For tobacco growers in Virginia, the 253 or 288 cell floats would be a good compromise between transplant size and transplant cost. This is especially important with outdoor float bed growers who must balance transplant number needed against the ability to adequately heat the float beds.

Attention to the seeding of trays will result in a greater number of usable transplants. Tray cells not seeded or double seeded will reduce the number of transplants. Proper dibbling of trays (creating shallow depressions in each cell) will provide better seed/media contact and position the seed in the center of the cells. The date that a greenhouse is seeded has a significant impact upon the management of a greenhouse. Seeding too early increases heating costs, lengthens the exposure of plants to possible pest problems, and requires excessive clipping. Sixty to 65 days is a conservative estimate of the time needed to allow for growing plants from seeding to transplanting time in a direct-seeded outdoor float bed.

Tobacco Transplant Production in Outdoor Float Beds

Outdoor float beds are a low cost method of greenhouse tobacco transplant production for limited acreage. Seedlings in outdoor float beds may be started by two different methods. The first is direct-seeding, as in a conventional transplant greenhouse. The alternative is to produce transplants using a seedling transfer production method.

Transfer beds are used only to grow plants off from a small seedling stage to transplant size. Seeds are not actually germinated in the outdoor transfer float bed. As a result, the heating requirement is greatly reduced since frost protection is the primary concern. The disadvantage of transfer beds is the increased labor necessary for hand transfer of the small seedlings to the float trays. The plug-and-transfer method was the original method of producing

burley transplants using the float system. Commercially-grown "miniplugs" or small seedlings are purchased in special trays and transferred by hand to conventional float trays. Seedlings are grown to transplant size in either an outdoor float bed or greenhouse. Although miniplugs represent an additional expense, they do reduce the risk and management associated with other float transplant production methods. In the seed-and-transfer method seedlings are started from conventional, uncoated seed and transferred to float trays in outdoor beds. Detailed directions for seed-and-transfer tobacco transplant production may be found later in this section of the production guide.

Float Bed Construction

Outdoor float beds may be designed and constructed in many different ways. Individual growers should consider the materials available and the desired expense when considering how to construct float beds. Factors to consider include: 1) adequate strength of the top, 2) providing sufficient heating, and 3) ease of access for observation and management of seedlings. Outdoor float beds evaluated at the Southern Piedmont Center in 1993 and 1994 have utilized a narrow design with a separate frame for the top that can be completely removed from the bed. Such a design allowed for excellent access to the seedlings, complete ventilation of the float bed, and clipping of the seedlings with a tractor-mounted bush-hog.

The size of the float bed(s) to be constructed will be determined by the required number of transplants, the ability to provide adequate heating, and the float tray cell size to be used. Float trays are approximately 13.5 in. wide and 26.5 in. long and vary in the number and size of cells in which the seedlings grow. Comparative information on the different float trays available is presented later in this section of the production guide.

The frame of the float bed should be sized to hold the desired number of trays and have approximately 2 in. of additional space along the length and width of the bed to allow ease of removal of float trays. Larger amounts of exposed water will encourage excessive algae growth.

One example of an outdoor float bed to grow transplants for the average-sized burley tobacco producer would be a 40 tray float bay. Trays in the bay could be arranged 5 wide (side-to-side) and 8 trays long (end-to-end). The inside dimensions of the float bay frame (2 x 6 in lumber) would be:

length = 8 trays x 26.5 in. + 2 in. = 17 ft. 10 in.

width = 5 trays x 26.5 in. + 2 in. = 5 ft. 10 in.

The number of transplants produced from this 40-tray float bed will be influenced by the float tray cell number and the percentage of usable transplants produced from each (dependent on management).

Float tray cell number	Number of transplants from 40 trays with 75% usable	90% usable
200	6000	7200
253	7590	9108
288	8640	10,368
338	10,140	12,168
392	11,760	14,112

If increased transplant number is needed, larger beds may be constructed. However, growers are reminded to consider the heating requirement, necessary structure strength of the top, and ease of management with larger float bed sizes.

The length of the bed can be made from 1 or more lengths of 2 x 6 treated lumber and joined securely. Short wooden stakes 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.

Suggested Sizes of Outdoor Float Beds

The following are suggested dimensions for the style of float beds evaluated at the Southwest Virginia and Southern Piedmont ARECs. These beds consisted of a 2 x 6 frame for the water bed and a 2 x 4 frame (turned up on the 2 in. side) around the water bed to attach cover support bows made from 3/4 in. flexible water pipe. The 2 x 4 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	17' 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	17' 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 1/2 or 3/4 in. plastic PVC 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.

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 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. Early research with outdoor float beds evaluated the use of ceramic heaters for direct-seeded outdoor float beds. However, the use of such heaters is discouraged due to the potential electrical hazard associated with outdoor float beds. The high electrical demand of ceramic heaters coupled with safety considerations limit their usefulness in heating outdoor float beds. Each ceramic heater requires a separate 20 amp circuit with a ground fault interrupt.

Water bed heaters (heat mat placed under the bed liner) have successfully been used for heating direct-seeded float beds. One heater per 20 trays should be sufficient if other necessary procedures are followed. Thermostats should be set at 80°F. Empty trays (one per water bed heater) should be placed in the bed to allow heat to move from the water to the air above the trays.

Heat loss, and therefore, the heating requirement can be significantly reduced by covering beds with solid plastic to reduce radiational heat loss occurring at night. Such covers should be provided when low temperatures are predicted to fall to 35°F or below.

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.

Covers for Outdoor Float Beds

Clear, solid plastic should not be used as a cover material for outdoor float beds. High temperatures may buildup very rapidly under solid plastic and kill young seedlings. The typical outdoor float bed does not have sufficient ventilation to prevent the buildup of excessive heat. 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, particularly during germination of the seed. 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 Southwest Virginia and Southern Piedmont ARECs. The very small holes in this material reduce the buildup of excessive heat, but are so small that rainfall cannot pass through the cover onto the plants. It is recommended that the heavier grade (2.5 mil) of this cover be used for float beds, and that the cover should be turned with the rough side up (to better shed water).

Resent research has shown the use of a 50% white shade plastic to be a very effective cover for outdoor float beds. Growers should be sure that the shade plastic is actually 50%. If the covering is higher percent shade, seedlings will become spindly for lack of sunlight., however, less shade would allow too much sunlight resulting in temperatures high enough to damage or kill seedlings.

An on-farm study showed fewer incidences of spiral root seedlings when produced using the 50% shade plastic with the outdoor float bed than in a traditional greenhouse. This was probably a result of higher humidity in the float bed and less drying of the seed and pellet.

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 1/2 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 1/2 in. tall).
   - Each germination 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.

DISEASE CONTROL FOR BURLEY TOBACCO

Charles S. Johnson, Extension Plant Pathologist, Tobacco

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

ACCURATE DIAGNOSES OF DISEASE PROBLEMS is the first step in controlling burley tobacco diseases. Note any signs of disease during the growing season. Contact your Cooperative Extension agent when you believe that a significant problem may be developing. 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 tobacco diseases and 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
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 also reduces overwintering populations of nematodes and disease-causing organisms, as well as many insects, grasses, and weeds. 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 Stalk and 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 may be the most cost-effective way to control disease. However, varieties resistant to black root rot and black shank are not immune to these diseases. Significant losses can still occur under heavy disease pressure. Crop rotation and early root destruction should be used along with resistance. Pesticide use may be necessary in fields with a history of extremely severe black shank.

DISEASE CONTROL IN TOBACCO GREENHOUSES

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

If tobacco mosaic (TMV) may have occurred in the previous year, greenhouse surfaces that may come in contact with plants should be disinfected. Such surfaces should include side-curtains, center walkways, and the 2x6 boards that form the float bays. However, there is no need to spray the purline supports or the plastic covers over the greenhouse. Relatively new float trays that may have been used when TMV may have been present should be washed and cleaned thoroughly before being fumigated. Old trays should be discarded and replaced with new trays. Mosaic has a number of weed hosts (horsenettle, ground cherry) which should be removed from the vicinity of tobacco greenhouses.

Float trays should be cleaned and then fumigated with methyl bromide or aerated steam (140^{0}F to 175^{0}F for 30 minutes) to minimize *Rhizoctonia* damping-off and sore shin. Dry trays should be loosely stacked no more than 5 ft high and completely enclosed in plastic. Three pounds of methyl bromide will fumigate 1,000 cubic feet (1,500 trays). Trays should be fumigated 24 to 48 hours, then aerated for at least 48 hours before use. Be sure to read the label for space fumigation and follow it exactly.

Do not fill float bays with water from surface water sources like streams or ponds. Water from these sources may be contaminated by soil run-off from fields infested with black shank or Granville wilt. Don't move water from one bay to another to reduce potential spread of water-borne pathogens. Be careful to avoid introducing disinfestants into water intended for plant uptake.

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

Condensation on the underside of the greenhouse top and on leaf surfaces creates conditions that favor disease. This condensation often results from a difference in temperature between the inside and outside of the greenhouse, particularly at sunset. Ventilating the greenhouse near sunset with horizontal airflow fans will help reduce potential condensation. Minimize

overhead watering and potential splashing of media from one tray cell to another. Correcting drainage problems in and around the greenhouse will also help avoid excess humidity.

Weekly application of ½ lb of Dithane DF per 100 gal of water (1 level tsp/gal) should start approximately 1 week after seedlings are big enough to cover the tray cells. Spray volume should increase from 3 to 6 gal/1,000 sq. ft. as plants grow. Fungicide application should continue until seedlings are transplanted.

Not seeding tobacco greenhouses and float beds until March, and eliminating any volunteer tobacco plants within these structures, should be an essential component of each growers' disease control plan. As a general rule, plants closely related to tobacco (tomatoes, peppers, etc) should not be grown in greenhouses used for transplant production.

SPECIFIC DISEASES IMPORTANT IN VIRGINIA

Black Root Rot:

Roots of infected plants are usually black in color and decayed, causing 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, 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.

Black Shank:

Any activity that moves soil from one place to another can spread this disease. Control practices should vary according to the number of plants expected to die from the disease. The following table presents generally appropriate practices to control different levels of black shank:

Severity Level	**Control Option**
Low (Less than 60 plants/acre)	Use a 2-3 year rotation and a moderately resistant variety (4-6 on the KY/TN scale).
Moderate (60 to 300 plants/acre)	Use a 3-4 year rotation with a moderately resistant variety. One to two applications of a recommended soil pesticide may be necessary if rotation length can't be increased.
High (more than 300 plants/acre)	Use a 4-5 year rotation with a resistant variety. Several applications of a recommended soil pesticide should also be made.

Black shank control with Ridomil Gold or Ultra Flourish improves when part of the fungicide is applied before transplanting, part at the first cultivation, and the rest is applied at layby.

Root-Knot and Lesion Nematodes are microscopic worms that live in the soil and feed on tobacco roots. *Significant nematode problems are usually found in fields continuously planted with tobacco.* Selection of rotation crops is very important. Legumes such as red clover, vetch, and soybeans are as susceptible to root-knot and lesion nematodes as tobacco. NC 2, NC 3, NC 4, and NC 5 are resistant to common root-knot nematodes.

Blue Mold:

Obtaining transplants locally will reduce the chances of introducing blue mold from tobacco production areas outside Virginia. Application of blue mold fungicides should begin as soon as disease has been predicted for your area by the Blue Mold Forecast System and local Extension advisories. Dithane and Acrobat must be applied using high pressure (~ 100 psi) and large amounts of water per acre. Diaphragm or piston pumps may be required to maintain adequate spray pressure. The following table illustrates the spray volumes required.

Crop Stage	Gallons of Spray Mixture/Acre	
	Air blast Sprayer	Hydraulic Sprayer
Before layby	10	20
Near layby	20	40
Waist-high plants	30	60
Chest-high plants	40	80
Near topping	50	100

Hollow cone (D3-23 or D3-25, for example) or disk-core (TX10 or TX 12) type nozzles should be used to ensure thorough coverage of all leaves.

Air blast sprayers can be used for small plantings. Fungicides should be mixed at twice the normal concentration when an air blast sprayer is used. However, spray volumes should be cut in half when using an air blast sprayer.

Complete coverage is not required when Actigard is used for blue mold control. However, tobacco plants need 4-5 days after application of Actigard before they are fully protected from disease. Initial use of Actigard should occur within 3 days of any previous fungicide application. If this is not possible, tankmixing the first Actigard spray with a fungicide will also help protect your crop while the plants are developing "systemic acquired resistance" to blue mold. Burley tobacco is sensitive to Actigard. Growers should follow the Actigard label very closely to minimize potential yellowing or stunting of the crop.

Regardless of the spray method used, applications of Dithane or Acrobat must be repeated weekly until blue mold is no longer a threat. However, Dithane and Acrobat may not be applied to burley tobacco within 30 days of harvest. The preharvest interval for Actigard is 21 days.

Products such as bleach and household cleaners may appear to control the disease at first, but have actually made blue mold problems worse in University tests.

Brown spot, Frogeye, Target Leaf Spot, and Ragged Leaf Spot:

Soil compaction, improper pH, nematodes, root diseases, and poor sucker control are often associated with epidemics of these diseases. Excessive fertilization should also be avoided. Cultural practices such as crop rotation and early destruction of tobacco debris reduce overwintering populations of the fungi that cause leaf diseases. Wider plant spacings can also help reduce leaf disease problems. No fungicides are available for control of these diseases. Losses from tobacco leaf diseases are most often minimized by harvesting quickly once the disease has been recognized as a problem.

Tobacco Mosaic Virus cannot be eliminated without crop rotation and early root destruction or use of mosaic-resistant varieties. Most burley varieties are resistant to tobacco mosaic virus. Use of manufactured tobacco products in the plant bed, greenhouse, and field should also be strongly discouraged. Washing hands with a 1% solution detergent about every half hour while handling transplants can also help reduce the spread of mosaic. If old boxes must be used, they can be decontaminated by scrubbing with a 1% detergent solution. Plants showing symptoms of mosaic before the first cultivation should be removed to prevent spread of the disease.

APPLICATION METHODS

The performance and safety of a chemical depends on 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 - Plant Bed applications should begin when plants are about the size of a dime. Applications should be repeated if sprays are washed off by rain or irrigation. Greenhouse applications should start when plants are large enough to cover the cell surface in which they reside. Field applications should be made when disease is predicted or threatens and repeated at 7-day intervals. Applications should also be repeated after rain. A disc-core (D3-45, etc.) or hollow-cone (TX-12) type nozzle should be used to apply foliar sprays to burley tobacco. Foliar fungicides should be applied at 100 psi in 20 to 100 gallons of water per acre. Both the tops and bottoms of leaves need to be covered. As the plants increase in size, the amount of water per acre should also be increased in order to get adequate coverage. The use of drop nozzles for field sprays will also help increase coverage.

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.

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

DISEASE RESISTANCE LEVELS OF SELECTED BURLEY VARIETIES[1]

	Black Shank				Black		Tobacco				
	Rating for Race 0		Rating for Race 1		Root	Fusarium	Mosaic		Brown	Blue	Aphid Transmitted
Variety	Verbal	KY/TN [2]	Verbal	KY/TN [2]	Rot	Wilt	Virus	Wildfire	Spot	Mold	Viruses
KT 200	M	6	M	6	H	S	H	H	--	S	M
HB 04P	S	0	S	0	H	--	H	H	--	S	S
KY 8959	S	1	S	1	H	S	S	H	--	S	M
KY 907	L	2	L	2	H	M	H	H	--	S	M
KY 910	H	10	M	4	H	L	H	H	--	S	S
VA 509	M	5	M	5	L	L	S	H	VS	S	S
HY 502	M	4	M	4	H	L	S	H	--	S	S
Clay's 403	S	0	S	0	M	M	H	H	--	S	S
Coop 313	S	1	S	1	MH	--	H	H	--	S	S
PF 561	M	5	M	5	H	L	H	H	--	S	S
B 21xKY 10	S	0	S	0	L	L	H	H	S	S	T
KY 14xL8	H	10	S	0	M	M	H	H	T	S	S
R-630[4]	M	4	M	4	M	L	H	H	--	S	M
R-711	S	0	S	0	M	L	H	H	--	S	S
R-712[4]	S	0	S	0	H	S	H	H	--	S	S
TN 86	M	4	M	4	H	S	S	H	--	S	M
TN 90	M	4	M	4	H	S	H	H	--	S	M
TN 97	M	5	M	5	H	S	H	--	--	S	M
NC 3 [3]	L	2	L	2	H	S	H	H	--	VS	L
NC 4 [3]	L	2	L	2	H	M	H	H	--	S	M
NC 5 [3]	H	10	M	4	H	S	H	H	--	S	M
NC 2000[4]	S	0	S	0	S	--	H	H	--	M	S
NC BH-129	S	1	S	1	H	S	H	H	--	S	S

[1] VS=very susceptible; S=susceptible; L=low resistance; M=moderate resistance; H=high resistance; T=tolerant.

[2]Rating on a 0-10 scale where 10=most resistant; Developed by the University of Kentucky-University of Tennessee Tobacco Task Force.

[3]Resistant to races 1 and 3 of the common root-knot nematode (*Meloidogyne incognita*).

[4]Tentative ratings base upon the limited information, ratings may change in the future.

PLANT BED FUMIGANTS

Disease	Chemical	Product	Rate/100 sq yds	Remarks
Nematodes and diseases	methyl bromide (98%) + chloropicrin (2%)	Brom-0-Gas (cans)	9.0-18.0 lb	Fall fumigation is preferred. Prepare seedbed as you would for seeding. You must use an airtight 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	7.7-11.0 lb	Aerate for 2 weeks before seeding.
		Terr-0-Gas 67	13.5 lb	
	methyl bromide (66%) + chloropicrin (33%)	Tri-Con 67/33	9.3 lb	
Nematodes, insects, weeds, damping-off, black shank	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)	Metam CLR	1.1 gal	
		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 gal/100 sq yd 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 lb in 5 gals water /100 sq yd	
	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. Begin applications before disease has been observed, but not before seedlings are the size of a dime. Use 3 gal of spray mixture /1000 sq. ft. (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.
Angular Leaf Spot or Wildfire *(Pseudomonas)*	Agrimycin 17, Agri-strep, etc. 100-200 ppm (2-4 tsp/3gal)	Foliar Spray	For blue mold suppression in plant beds (only).
Pythium Root Rot (*Pythium* spp.)	Terramaster 35WP	2 oz/100 gal of float bed water	Can be used before or after symptoms appear, but no earlier than 2 weeks after seeding. If symptoms reappear, a second application can be made no later than 8 weeks after seeding. MUST BE EVENLY DISTRIBUTED; when mixing, first form dilute slurry, then distribute slurry evenly and thoroughly in float bed water.

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	2 pt	Preplant	F	---	---
Ultra Flourish	2 qt	Preplant	F	---	---
Ridomil Gold EC	1.0 pt + 1.0 pt	Preplant + layby	G	---	---
Ultra Flourish	2 qt + 2 qt	Preplant + layby	G	---	---
Ridomil Gold EC	1 pt + 0.5 - 1.0 pt + 0.5 - 1.0 pt	Preplant + 1st cultivation + layby	VG	---	---
Ultra Flourish	1 qt + 1-2 qt + 1-2 qt	Preplant + 1st cultivation + layby	VG	---	---
Telone C 17	10.5 gal	F-Row	F	F	G
Chlor-O-Pic	3 gal	F-Row	F	F	G
Chloropicrin 100	3 gal	F-Row	F	F	G
Tri-Con 67/33	6 gal	F-Row	F	F	G
Terr-O-Gas 67	6 gal	F-Row	F	F	G

[1] F-Row – inject 8 inches deep in row with single shank in center of row. Do not use more than a total of 3 qt of Ultra Flourish, or 3 pt of Ridomil Gold EC per acre. Drop nozzles should be used to apply these fungicides at layby.

[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.

FIELD DISEASES OF TOBACCO (Cont'd)

Foliar Diseases - Blue Mold

Chemical	Material	Rate[1]	Application Method[2]	Comments
Systemic Fungicide				
Acibenzolar-S-methyl	Actigard 50WP	0.5 oz/20 gal/A	Foliar	Do not apply to seedlings. Treated plants require 4-5 days to fully respond to each application. Only 2 sprays are allowed; the first when plants are 18 inches tall, and the second 7-10 days later.
Mefenoxam	Ridomil Gold EC	0.5-1 pt + 0.5 pt/A	Preplant + Layby	Most strains of the blue mold pathogen in 1995-2001 were insensitive to mefenoxam. However, mefenoxam will control sensitive strains early in the season, as well as *Pythium* damping-off. Read precautionary and rotation crop restrictions.
	Ultra Flourish	1-2 pt + 1 pt/A	Preplant + Layby	
Protectant Fungicide				
Dimethomorph and Mancozeb	Acrobat MZ	2.5 lbs per 100 gal of water	Foliar Spray	Begin sprays when the Blue Mold Advisory predicts disease and continue on a 5-7 day interval until the threat of disease subsides.
Mancozeb	Dithane DF	1.5 - 2.0 lbs per 100 gal of water	Foliar Spray	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. Do not exceed 2.5 lb/A of Acrobat per application or 10 lb/A per season. Do not apply after the early button stage or within 21 days of the first harvest.

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

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

FIELD DISEASES OF TOBACCO (Cont'd)

There Are No 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. Avoid practices that would leave mature leaves in the field or delay the maturity of the tobacco. Harvest early when lesions appear on dry leaves.
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 (sclerotia) may also be found attached to severely infected plant parts. Sclerotia may be carried to the field by infected plants. Infected plants, as well as plants immediately adjacent to diseased areas, should be discarded as soon as possible. Improving ventilation and reducing excess moisture will 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 overfertilization with nitrogen. Use a 2-year rotation and be sure to plow refuse under early.

FIELD DISEASES OF TOBACCO (Cont'd)

There Are No 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.
Southern Stem and Root Rot (*Sclerotium rolfsii*)	This disease often occurs first in the plant bed, so disinfecting the bed is important. Choose disease-free transplants. There is no field control. Resistant varieties are not 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, etc.)	Once a plant is infected, it remains infected for life. See special note on viruses.
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)	Rotation is recommended. Streptomycin sulfate is used in the plant bed to obtain bacterial-free transplants. In addition, streptomycin sulfate can be used in the field.

WEED CONTROL IN BURLEY TOBACCO

Charles S. Johnson, Extension Plant Pathologist, Tobacco

Good weed control uses crop rotation, early root destruction, cultivation, and appropriate use of herbicides. Most weeds found in tobacco fields can be controlled by several cultivations. However, poor weed control may result when rain prevents cultivation 1 to 3 weeks after transplanting. Use of a herbicide will reduce dependence on the first cultivation for early season weed control. The number of cultivations can often be reduced when a herbicide has been applied. Some herbicides may also be applied to the row middle 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, and herbicide cost in relation to performance, 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 summary of herbicide performance for weeds found in burley 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 – Most 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 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. Ensure that the spray solution is continuously agitated. Do not apply a herbicide in strong wind, since wind can cause uneven coverage. Never leave a spray mixture in a sprayer overnight!

Herbicide Incorporation - All herbicides should be incorporated as soon after application as possible. Avoid using a large field disc to incorporate PPI herbicides. Use 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 or irrigation is often required to incorporate tobacco herbicides applied after transplanting. 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 PPI Applications on Early Season Tobacco Growth - PPI herbicides can sometimes inhibit root development of transplants, delaying plant growth during the first month after transplanting. However, diseases, insects, unfavorable growing conditions, poor transplants, fertilizer and/or fumigant injury can also delay early season growth and development of tobacco. Possible early season growth reductions by herbicides can be avoided by surface application at transplanting or 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 PPI; and 3) deep plowing before seeding the fall crop.

Plant Bed Herbicides

Adequate weed control in burley tobacco plant beds can usually be obtained by fumigation. Poast herbicide may be applied to control emerged grasses. Special care is needed when mixing Poast. First fill the sprayer with ½ to ⅔ of the water needed to make the application. Add the oil concentrate first, then Poast, and then the remaining volume of water. Agitation must be maintained continnously while mixing and applying Poast. Don't apply Poast: (1) at rates above 2 tsp (0.33 oz.)/100 sq. yd. of plant bed; (2) more than once per season; (3) to grasses under stress; (4) if rainfall is expected within 1 hour; (5) with any other pesticide, additive, or fertilizer except as specified on the Poast label; or (6) through any type of irrigation system.

Preplant Incorporated Herbicides (PPI)

Apply the herbicide in an even broadcast application. Avoid spray overlap! Use fan-type (8004, etc.) or flood-jet (TK2, TK4, etc.) nozzles. Incorporate the herbicide immediately after application using recommended equipment.

Over-the-Top After Transplanting (OT) & 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 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.). 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.). Be sure to use the recommended amount of product per acre.

Layby herbicides are applied as directed sprays to the row middles immediately after the last normal cultivation. The last cultivation should leave the row middles weed-free. Use commercially available drop nozzles equipped with flat, flood-jet (TK2, TK4, etc.) or even, flat-fan (8004, etc.) nozzles that allow you 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 in fields where spray nozzles on the end of the boom pass over the same row middle twice (to prevent over-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, restrictions, and special precautions 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
Poast	E	E	G	G	E	E	G	E	E	N
Prowl	G	G	E	E	G	E	E	G	G	N
Spartan	F	P	F	F	F	F	F	F	F	E
Tillam	G	P	E	E	G	E	G	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
Poast	N	N	N	N	N	N	N	N	N	N	N
Prowl	G	N	N	G	N	G	G	N	N	P	P
Spartan	G	G	G	G	G	G	G	G	F	--	G
Tillam	G	N	N	G	N	G	G	N	N	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 (see remarks)	dazomet (99%)	Basamid Granular	7.5 lb	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.
	methyl bromide (98%) + chloropicrin (2%)	Brom-O-Gas (cans)	9.0-18.0 lb	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.
		Terr-O-Gas 98 (cylinders)	9.0-18.0 lb	
	methyl bromide (69%)	MBC	7.0 to 11.0 lb	Allow 2 weeks aeration prior to seeding.

PLANT BED WEED CONTROL (continued)

Weed Problem	Chemical	Product	Rate/100 sq. yds	Remarks
Weeds, nematodes, insects, damping-off, black shank	methyl bromide (66%) + chloropicrin (33%)	Terr-O-Gas 67	13.5 lb	Same as for previous remarks. Use higher rates for high pest infestations.
		Tri-Con 67/33		
	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 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.
	metham (42%) (SMDC)	Metam CLR	1.1 gal	
		Sectagon 42	1.25 gal	
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. Do not spray tobacco seedlings less than 1 inch in diameter. Remove plant bed covers and allow leaves to dry before spraying. Maintain continuous agitation during application. Allow spray to dry before replacing plant bed covers. Do not apply to plant beds more than once per season.

WEED CONTROL IN BURLEY 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,		clomazone	Command 4EC	PPI, OT	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.
	Coarse	0.75	1.5 pt		
	Fine	1.0	2.0 pt		
jimsonweed, lambsquarter, prickly sida, purslane, spurred anoda, venice mallow, common ragweed, smartweed, cocklebur (suppression), shattercane		clomazone	Command 3ME	OT	
	Coarse	0.75	2.0 pt		
	Fine	1.0	2.7 pt		
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, OT, Layby	For PPI application, incorporate the same day as applied. Small grain injury may occur with PPI application method.
	Coarse	1.0	2.0 lb		
	Medium	1.0-1.5	2.0-3.0 lb		
	Fine	2.0	4.0 lb		
			Devrinol 2E		
	Coarse	1.0	2 qt		
	Medium	1.0-1.5	3 qt	PPI	
	Fine	2.0	4 qt	only	

WEED CONTROL IN BURLEY TOBACCO FIELDS (continued)

Weed Problems	Soil[1] Texture	Chemical Lbs Active Ingredient/A	Product per Acre	Applic.[2] Method	Remarks
Cocklebur, Florida pusley, hairy galinsoga, goosegrass, 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.		sulfentrazone	Spartan 75DF	After bedding,	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 ground-water. *Most tobacco fields in Virginia contain coarse to medium textured soils. Do* not impregnate on fertilizer. Apply to soil surface after field has been prepared for planting. Apply within 14 days of transplanting, **after** beds are knocked down for planting. **Do not** apply at or after transplanting. Do not disturb treated soil below a 2 inch depth. *Crop injury can occur when incorporation is poor, transplants are set too shallow, or heavy rain falls near transplanting.* **Do not** apply Spartan more than once per season. Do not seed small grains within 4 months of application. Do not plant cotton or canola within 18 months of use.
	Coarse	0.25	5.3 oz	before	
	Medium	0.31	6.7 oz	transplanting	
	Fine	0.38	8.0 oz		
			Spartan 4F	After bedding,	
	Coarse	0.25	8 fl oz (0.50 pt)	before	
	Medium	0.31	10 fl oz (0.62 pt)	transplanting	
	Fine	0.38	12 fl oz (0.75 pt)		

WEED CONTROL IN BURLEY TOBACCO FIELDS (continued)

Weed Problems	Soil[1] Texture	Chemical Lbs Active Ingredient/A	Product per Acre	Applic.[2] Method	Remarks
Grass weeds and volunteer small grain	All types	sethoxydim	Poast	post-emergence	Apply to actively growing grasses at 40-60 psi in 5-20 gal/A through hollow cone or flat-fan nozzles. May be banded or applied broadcast. Do not apply more than 4 pt/A per season (including use in tobacco plant beds).
	Single use:	0.19	1.5 pt + 2.0 pt oil concentrate		
	Sequential use:	0.28	1.0 pt + 2.0 pt oil concentrate		
Annual spurge, barnyardgrass, carpetweed, crabgrass, crowfootgrass, Florida pusley, foxtails, goosegrass, johnsongrass from seed, lambsquarters, panicums, pigweed, purslane, signalgrass.	Coarse	pendimethalin 0.75	Prowl 3.3EC 1.8 pt	PPI, Layby	Apply chemical up to 60 days prior to transplanting. Incorporate into the soil within 7 days after application. Read precautionary statements.
	Medium	0.75-1.0	1.8 pt		
	Fine	1.0-1.25	2.4-3.0 pt		
Barnyardgrass, bermudagrass, crabgrass, crowfootgrass, Florida pusley, foxtails, goosegrass, ground cherry, lambsquarters, henbit, pigweed, purslane, purple and yellow nutsedge	All types	pebulate 4.0	Tillam 6E - 2.6 qt	PPI	Incorporate immediately after application. Read precautionary statement.

[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.

INSECT CONTROL ON TOBACCO

Paul J. Semtner, Extension Entomologist

MANAGEMENT OF TOBACCO INSECTS

Several insect pests pose serious threats to Virginia's tobacco crop. Insects injure tobacco in the field, the plant bed, the greenhouse, and in storage. The proper management of these pests prevents economic losses in yield and quality and usually reduces insecticide use. The integrated pest management (IPM) approach to pest control uses all available practices including chemical, cultural, and natural controls. These practices help maintain pest populations below levels that cause economic crop losses. IPM promotes the application of pesticides only when they are needed. It 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. In addition, the plants can compensate for some insect damage. As a result, IPM helps to maximize profits. Production costs, pesticide residue levels, environmental contamination, and human exposure to pesticides are reduced through the use of IPM. IPM also favors predators, parasites and pathogens that help regulate pest populations.

Chemical control

Economic thresholds and field scouting are important tools in IPM. The economic threshold is that pest population or injury level that requires treatment with an insecticide to prevent economic damage to the crop. Fields are scouted or sampled at regular intervals (once a week) to determine when insect pests reach their thresholds. Threshold information is then used to time foliar applications of insecticides. If an insecticide is applied too soon, production costs, environmental contamination, and pesticide residues may increase. However, delaying insecticide application for too long after the threshold is reached can cause excessive damage that reduces tobacco yield and quality. Insecticides applied as foliar, transplant water and soil treatments are extremely important tools in an IPM program. Many cultural and natural controls help reduce insect outbreaks, but it is almost impossible to grow a high yielding, high quality crop without using some insecticide.

Cultural controls

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

1. **Early plowing in the spring.** This practice reduces wireworm and cutworm infestations.
2. **Proper nitrogen fertilization**. Higher than recommended rates of nitrogen delay maturity and make tobacco a more favorable host for hornworms and aphids late in the season.

3. **Adjustments in transplanting date.** This can change the susceptibility of tobacco to some insect pests. Early planted tobacco is usually less susceptible to aphids and hornworms and more susceptible to flea beetles. Late planted tobacco is highly susceptible to hornworm damage. Transplanting too late can reduce tobacco yield and quality.

4. **Destroy plant beds immediately after transplanting is completed.** This prevents aphids, flea beetles and other insects from building up high populations in plant beds and moving to field tobacco.

5. **Management of field borders**. Keep field margins clear of weeds and tall grass to reduce the number of grasshoppers, cutworms and other insects that move from these sites into tobacco fields. When cutting hay, leave uncut barriers between tobacco fields and hayfields containing high numbers of grasshoppers.

6. **Early topping in the button or prebutton stage.** This practice eliminates food sources for budworms and makes the plants less desirable food sources for aphids and hornworms.

7. **Obtain effective sucker control.** This reduces food sources for hornworms, budworms and aphids.

8. **Root destruction immediately after harvest.** This practice reduces feeding and overwintering sites for hornworms, budworms, and flea beetles. It is most effective when done on an area-wide basis.

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

Natural Controls

Beneficial organisms, including insects and insect pathogens, often help reduce the injury caused by insect pests. An important group of parasites and predators often helps maintain budworm populations below damaging levels. In some years, several parasitic wasps kill more than 80% of the budworms in tobacco fields. This level of budworm control is similar to that obtained with the most effective foliar insecticides. Hornworms and aphids also controlled by beneficial organisms on tobacco. The hornworm parasite *Cotesia congregata* forms egg-like cocoons on the backs of hornworms. Stilt bugs are slender, long-legged bugs that feed on hornworm and budworm eggs. Several species of lady beetles and their larvae prey on aphids and other insects. In addition, a fungal pathogen helps control aphids late in the season. However, beneficials usually do not reduce aphid populations enough to prevent serious damage. Certain weather conditions also reduce insect pest problems. The combination of high temperature and predator activity or high humidity and a fungus disease can rapidly reduce aphid populations. Consider beneficial insects when deciding whether or not to apply an insecticide to control an insect pest. Use economic thresholds to minimize the impact of insecticide applications on beneficial insects. Select the insecticides such as B*acillus thuringiensis* (Bt), pymetrozine (Fulfill) spinosad (Tracer) and Lannate to minimize the impact on beneficial insects.

Transplant water and tray drench applications of Admire and Platinum also have low impact on some beneficial insects.

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 survival, 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 usually can be produced without extensive use of insecticides. 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.**

Eliminate hiding places for overwintering tobacco insect pests by keeping the area within 100 ft of the plant bed free of tall weeds, decaying plant material, and trash. 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 transplanting is completed eliminates potential breeding sites for tobacco insects and pathogens.

Insect Control on Transplants Produced in the Greenhouses

In Virginia, most burley tobacco transplants are grown in greenhouses or outdoor float beds. 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 reductions in growth and stand. Ants can remove seeds from the trays and cause poor stands. Green June beetle grubs can feed on and uproot plants. Aphids may build up heavy infestations that reduce plant vigor, and they are carried to the field on infested plants. Mice have seriously reduced plant stands in some greenhouses by removing the seeds from float trays. Entire greenhouses have had to be reseeded due to this damage.

Cultural controls

Keep the area around the greenhouse clean and free of weeds, decaying plant material, leaves, hay, plastic, and other protected sites for insects and other pests. Cutworms, crickets, grasshoppers, mice, slugs 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, insect pests can develop on these crops and move to tobacco. Therefore, you should allow a fallow period between crops. This reduces the chances that pests such as aphids and whiteflies will move to the tobacco seedlings. Very cold or hot conditions during this fallow period can reduce potential pest problems.

Chemical control

Acephate (Orthene) is the only effective insecticide labeled for use on tobacco transplants grown in greenhouses. It provides good to excellent control of aphids, cutworms, flea beetles and vegetable weevils. Acephate should be applied to the seedlings as a foliar spray and not in the float water. Apply the proper rate because too much Acephate can injure or kill young plants. MPede (insecticidal soap) is labeled for use on greenhouse tobacco seedlings. It is not effective against aphids, but gives fair control of whiteflies. Metaldehyde (Deadline Bullets) bait controls slugs and snails in the greenhouse. Do not use methaldehyde in float beds. Mice should be controlled with poisonous baits in combination with trapping and cultural controls.

Insect Control on Newly Transplanted Tobacco

Wireworms

Wireworms, the larval stages of click beetles, 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 1 to 5 years. 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 an insecticide labeled for wireworm control. Soil insecticides should be applied broadcast and incorporated thoroughly at least 2 weeks before transplanting. Another option is to use the wireworm rates of Admire or Platinum applied as transplant water or tray drench treatments. Plowing fields in early spring reduces 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 insecticide. If replanting is not possible, cultivation and irrigation may help plants recover and reduce losses.

Cutworms

Cutworms feed on or cut off leaves and plants. This injury can cause enough damage and stand loss to require replanting. However, since tobacco compensates well, a few

missing plants (less than 5%) has no impact on yield. Cutworm infestations are very sporadic and difficult to predict. However, plowing fields in the early spring usually reduces cutworm populations. Check fields for cutworm damage once or twice a week during the first month after transplanting and apply a remedial foliar treatment if it is needed.

White-fringed beetles

White-fringed beetle grubs have become serious problems in some burley tobacco fields. Outbreaks usually occur in fields that have been planted previous year in legumes such as clover, soybeans or alfalfa that are excellent food for the grubs. Most grasses are unfavorable hosts. The grubs feed on and destroy the outer surface of the roots and lower stems of newly transplanted tobacco. This injury can cause severe stunting and yield reductions. The rotation of tobacco with good stands of grass containing few legumes or broadleaf weeds is the most effective control. No insecticides are currently registered for control of white-fringed beetle on tobacco. A test conducted in Lee County, Virginia suggests that greenhouse tray drench and transplant water applications of Admire and Platinum may aid in the control of white-fringed beetles.

Soil-incorporated Insecticides

Pretransplant soil applications of insecticides can provide effective control of wireworms, flea beetles, aphids, cutworms, and nematodes on tobacco. However, foliar insecticides applied the economic thresholds provide effective control of insects feeding on tobacco foliage at lower cost than the systemic insecticides applied to the soil. In addition, preventive applications of Admire and Platinum applied as greenhouse tray drench or transplant water treatments provide good control of wireworms, flea beetles and aphids and they are less hazardous to the applicator and field workers than the soil insecticides.

Several things should be considered before selecting a soil insecticide. Decide which pests must be controlled with a soil treatment (Table 1). Is there a field history of soil insect or nematode problems? Sample the fields for nematodes as described in the disease control section of this guide. Lorsban, Mocap and Furadan 4F control both insects and nematodes. If a tobacco field has been in sod, weeds, or small grains during the previous year or has a history of wireworm problems, an insecticide should be applied for wireworm control. Admire or Platinum also provides good control of wireworms and superior control of aphids and flea beetles.

Table 1. Ratings of soil and transplant water and greenhouse tray treatments for control of insects on burley tobacco.

	Leaf feeding insects		Soil insects	
Insecticide	Aphids	Flea Beetles	Cutworms	Wireworms
Admire TW	5	2	0	3
TD**	5	4	0	3
Furadan 4F	0	4	2	2
Lorsban	0	2	3	4
Mocap	0	2	3	3.5
Orthene (TW)	2	3	4	0
Platinum TW	5	3	0	3
TD	5	4	0	3

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

** TW = Transplant water, TD = Transplant tray drench.

Remedial Control of Insects on Larger Tobacco

Scouting 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) Good samples are essential for determining the proper timing of insecticide applications. Sample for insect pests and their damage on at least 50 plants in a field (1-10 acres). Make counts and record the data for 5 consecutive plants at 10 locations throughout the field. If a field is planted on two different dates or if there are great differences in average plant size from one section of the field to another, divide the field into two or more sections and sample each separately.

2) Hornworms, budworms, flea beetles, and aphids are the most important insect pests feeding on tobacco foliage in Virginia so they are the primary targets of an insect scouting program.

   a. Check for flea beetles for the first 4 weeks after transplanting and after topping in late July and August. Check for cutworm and wireworm damage during the first month after transplanting.

   b. Check for hornworms and aphids from 3 weeks after transplanting until harvest is completed. Hornworms are most important after topping.

   c. Check for budworms from 3 to 4 weeks after transplanting until about a week before topping.

3) Scout each plant as follows:

   a. Check the bud region for budworm damage.

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

c. Check the entire plant for hornworm damage, locate the hornworms, note their size (are they 1 inch long or longer) and whether they are parasitized by *Cotesia congregata* (white egg-like cocoons on hornworm's back).

d. Examine the undersides of mid- and upper-stalk tobacco leaves for aphids. Count the plant as infested if there are 50 or more aphids on any one leaf.

e. Check the upper surfaces of the middle and lower leaves for honeydew, sooty mold, 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 it and samples of its damage and ask your local Extension agent for assistance. Beneficial insects or minor pests are often mistaken for serious pests. If a pest is misidentified, the wrong insecticide may be used for its control.

4) Treat tobacco fields with a registered insecticide when one or more insect pests meet or exceed the economic threshold levels given in Table 2.

Table 2. Economic thresholds for various insects on tobacco.

Insect	Economic threshold
Aphids	50 or more aphids on at least 1 upper leaf on 5 of 50 plants.
Budworms	5 plants infested with 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 week-old plants, 60 beetles per plant on tobacco more than 4 weeks old.
Grasshoppers	10 grasshoppers per 50 plants.
Hornworms	5 larvae (worms) at least 1 inch long per 50 plants. Do not count worms with the egg-like cocoons of the hornworm parasite on their backs. For hornworms ½ to ¾ inch long, treat when there is 1 hornworm 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. Tobacco

plants usually compensate for this damage and yield and quality may not be affected. However, budworms sometimes top tobacco plants. This results in early sucker growth that can cause plant stunting and the need for extra labor to remove the suckers. After the button stage, budworms rarely cause economic damage. 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) commercial baits 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 wasps (*Campoletis* and *Microplitis*) that parasitize budworms on the leaves near the bud. These cocoons are about ¼ inch long and white or grayish in color. The *Campoletis* cocoons have 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 parasite cocoons in the bud region. These parasites provide good natural control of budworms in Virginia.

Table 3. Rating of foliar insecticides for control of insect pests on burley tobacco.

Insecticide	Aphid	Bud-worm	Cut-worm	Flea-beetle	Grass-hopper	Horn-worm
Actara	4	0	0	3	0	0
Agree, Condor, Crymax, Dipel, Javelin, Lepinox, XenTari (*Bacillus thuringiensis*) Spray	0	2	0	0	0	5
Dipel (*Bacillus thuringiensis*)10G Bait	0	5	0	0	0	3
Fulfill	3	0	0	0	0	0
Lannate	2	3	0	3	0	5
Orthene/Acephate/Address	4	3	4	3	4	5
Provado	4	0	0	3	0	0
Sevin	0	3	3	3	3	4
Thiodan/Golden Leaf Tobacco Spray/Phaser	3	3	0	3	0	5
Tracer	0	4	0	0	0	5

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

Hornworms

Tobacco and tomato 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 damage is most severe during June, August, and September. Hornworms with white egg-like cocoons of the parasitic wasp, *Cotesia congregata*, on their backs eat much less than healthy hornworms. These hornworms also provide a source of parasites that help reduce the next generation of hornworms. Predators kill large numbers of larvae less than 1 inch long. This is the reason that

smaller hornworms are not considered in determining the economic threshold. In addition, these small hornworms cause very little damage and have no effect on yield or quality. Direct sprays to the upper one-half of the plants for optimum control of hornworms. See insecticide ratings in Table 3. Several cultural practices help reduce the susceptibility of tobacco to hornworms. Early topping, early transplanting, effective sucker control and fertilization with recommended rates of nitrogen help reduce late-season infestations. Stalk cutting and root destruction on an area-wide basis immediately after harvest reduces overwintering populations.

Aphids

The tobacco or green peach aphid has been the most severe insect pest of tobacco in Virginia for the past three decades. It may infest tobacco seedlings in plant beds, but the most severe damage occurs on field tobacco from late June to September. Aphids are sometimes introduced into the field on infested tobacco transplants. However, winged aphids that fly into fields and deposit the young wingless nymphs on tobacco plants are the most important source of infestation. 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 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. These often remain on the leaves after the aphids have been controlled.

From early June to the end of August, producers should watch for increases in aphid populations. Make regular examinations of the undersides of leaves from the middle and upper regions of the plants to determine the when aphid control is necessary.

Use the following practices to manage aphids on tobacco:

1. **Make remedial applications of foliar insecticide at the economic threshold (Table 2)** before aphids develop high populations that are difficult to control. Aphids are easiest to control when they are treated early and they will be much easier to control for the rest of the season. See insecticide ratings in Table 3.

2. **Give the insecticide time to work**. Since most insecticides take 1 to 3 days to control aphids, wait 3 to 4 days after application before assessing control.

3. **Obtain good coverage with foliar insecticides**. Some insecticides must contact the undersides of the leaves where most aphids are found for effective control. The use of higher gallonage (25 to 50 gal/acre), higher sprayer pressure (at least 60 psi), drop nozzles, and spreader-stickers may 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**. Do not use the same foliar insecticide for aphid control throughout the season. Continuous use of the same insecticide favors the development of insecticide resistance. There are several insecticide classes to chose from for aphid control including the organophosphate (Orthene), chlorinated

hydrocarbon (Golden Leaf Tobacco Spray/Phaser), chloronicotynil (Provado, Actara), and pyridine azomethine (Fulfill). Apply these insecticides as far from the next priming as possible and observe the preharvest interval stated on the label. **Do not apply Thiodan/Golden Leaf Tobacco Spray/Phaser after topping.**

6. **Make preventive applications of Admire or Platinum.** These treatments give excellent control of aphids throughout the season.

7. **Use cultural practices to reduce aphid populations**. Most cultural practices do not keep aphid populations below the economic threshold but they can reduce the number of insecticide applications needed for aphid control. 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 the plant bed and greenhouse**. 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 the impact of the aphids is not as great as it is on tobacco planted later in the season.

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

   e. **Top early**. Aphid populations decline rapidly after topping, especially during hot, dry weather. Fields should still be watched closely after topping because aphids can quickly build up to damaging levels.

Tobacco flea beetles

Adult tobacco flea beetles feed on the leaves and stalks of tobacco in the plant bed and in the field. 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 beetles on 20 plants (2 per field-sample location). **Apply treatments for flea beetles on newly set tobacco when there are 4 or more beetles per plant**. Larger plants can tolerate very high flea beetle densities, but an insecticide 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. Root destruction immediately after harvest and harvesting at the normal time are the most effective cultural practices for reducing flea beetle damage.

Insecticide Application Methods

Apply insecticides properly for the best control of insects. On small tobacco, direct one solid-cone or hollow-cone nozzle per row to the bud. Operate equipment at 40 to 60 pounds pressure, do not exceed 5 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. Use 40 to 60 pounds pressure 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. **Plant tobacco uniformly so that the space between rows is constant. This makes it easier to place insecticides where they are needed on the plants.**

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

Insecticide	Restricted entry intervals (hours)	Preharvest interval (days)
Foliar treatments		
Acephate (Orthene/Acephate AG/Address)	24	3
Bacillus thuringiensis (Agree, Condor, Crymax, Dipel, Javelin, XenTari)	4	0
Bacillus thuringiensis (Lepinox)	12	0
Carbaryl (Sevin)	12	0
Endosulfan (Golden Leaf Tobacco Spray/ Phaser/Thiodan)	24	5
Imidacloprid (Provado)	12	14
Methomyl (Lannate)	48	7
Pymethozine (Fulfill)	12	14
Spinosad (Tracer)	4	3
Thiamethoxam (Actara)	12	14
Soil treatments		
Carbofuran (Furadan)	48	"
Chlorpyrifos (Lorsban)	24	"
Ethoprop (Mocap)	48	"
Fenamiphos (Nemacur)	48	"
Metaldehyde (Deadline Bullets)	12	"
Greenhouse float tray or transplant water treatments		
Acephate (Orthene)	24	-
Imidacloprid (Admire)	12	-
Thiamethoxam (Platinum)	12	-

Plant Bed Insects

Insect	Insecticide and formulation	Rate per 1000 sq ft	Remarks and precautions
Aphids, flea beetles, grasshoppers, vegetable weevils	Acephate (Orthene/ Acephate AG/ Address) 75S	1 tbs in 3 to 6 gal water (1 lb/acre)	Spray plants as needed. Do not pull plants until 24 hours after treatment
	(Orthene) 97	¾ tbs/acre in 1 gal	
Aphids, flea beetles	Endosulfan (Golden Leaf Tobacco Spray/Phaser/ Thiodan) 3EC	⅔ qt/100 gal (3 to 6 gal/100 sq yds)	
Cutworms	Acephate (Orthene/ Acephate AG/ Address) 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.
	(Orthene) 97	¾ tbs in 1 gal	
	Carbaryl (Sevin) 5% Bait	½ to 1 lb	Apply to alleys and around margins of plant bed. Do not apply directly to plants. May be phytotoxic.
Green June beetle larvae	Carbaryl (Sevin) XLR Plus 4EC	12 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	
	(Golden Leaf Tobacco Spray/Phaser/ Thiodan) 3EC	⅔ pt/100 gal	Drench at 1 gal per square yard.

Plant Bed Insects (cont'd)

Insect	Insecticide and formulation	Rate per 1000 sq ft	Remarks and precautions
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 ½ 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/ Acephate AG/ Address) 75S	1 tbs/3 gal of water (1lb/acre)	Apply as a spray. **Over application can cause plant injury. Do not apply through an irrigation system.**
	(Orthene) 97	¾ tbs/3 gal of water (¾ lb/acre)	
Snails and slugs	Metaldehyde (Deadline Bullets) 4% bait	¼ to ½ 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, thrips	Imidacloprid (Admire) 2F	1fl oz	Apply as a drench to trays or flats prior to transplanting. Wet plants before application. Mix chemical with water before application and keep agitated or mix regularly to avoid settling in tank. Water plants immediately after application using enough volume to remove all white residue from the foliage and to wash it into the potting media. Transplant within 3 days. Do not apply Actara or Provado to tobacco already treated with Platinum.
	Thiamethoxam (Platinum) 2SC	0.8 to 1.3 fl oz	
Wireworms	Imidacloprid (Admire) 2F	1.4 to 2.8 fl oz	
	Thiamethoxam (Platinum) 2SC	1.3 fl oz	

Insects on Field Tobacco - Pretransplant Soil Treatments

Insect	Insecticide and formulation	Rate per acre	Remarks and precautions
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, apply at least 14 days before transplanting. **Restricted Use.**
Flea beetles, wireworms	Carbofuran (Furadan) 4F	1 to 1 ½ gal	
Wireworms	Ethoprop (Mocap) 6EC	1 1/3 to 4 qt	Make broadcast applications at least 2 weeks before transplanting. Band applications are usually less effective than broadcast treatments. Incorporate insecticides at least 4 inches into the soil immediately after application. Lorsban is registered for cutworms and flea beetle larvae too. **Mocap is a restricted use chemical.**
	(Mocap) 10G	20 lb	
	Chlorpyrifos (Lorsban) 15G	13 1/3 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, (suppression of aphids)	Acephate (Orthene/ Acephate AG/ Address) 75S	1 lb	Orthene provides flea beetle control for 3 to 4 weeks after transplanting and it suppresses aphids infestations for 4 to 6 weeks. Admire and Platinum usually give excellent season-long control of aphids. Apply treatments in at least 100 gal of water/acre. Higher amounts of water should be used for greenhouse transplants. **Calibrate transplanters and allow tanks to run low before refilling.** Do not apply Actara or Provado to tobacco already treated with Platinum.
	(Orthene) 97	¾ lb	
Aphids, flea beetles, thrips	Imidacloprid (Admire) 2F	1.0 fl oz/ 1000 plants	
	Thiamethoxam (Platinum) 2SC	5 to 8 fl oz	
Wireworms	Imidacloprid (Admire) 2F	1.4 to 2.8 fl oz/ 1000 plants	
	Thiamethoxam (Platinum) 2SC	8 fl oz	

Insects on Field Tobacco - Foliar Treatments

Insect	Insecticide and formulation	Rate per acre	Remarks and precautions
Aphids	Acephate (Orthene/ Acephate AG/ Address) 75S	2/3 to 1 lb (4 to 6 tsp/gal)	Apply as a spray in 10 to 50 gal/acre. Use highest rate for heavy infestations. If tobacco is large and aphids are established on the lower leaves, use drop nozzles to orient spray to undersides of leaves for improved control. Prime before treating.
	(Orthene) 97	½ to ¾ lb (1 to 1 ½ tbs/gal of water)	
	Endosulfan (Thiodan/ Golden Leaf Tobacco Spray /Phaser) 3EC	2/3 to 1 1/3 qt	Apply as a spray. Repeat in 5 days if necessary. **Do not apply after topping.**
	(Thiodan) 50 WP	1 to 2 lb	
	Imidacloprid (Provado) 1.6F	2 to 4 fl oz	Apply as spray.
	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	
	Pymetrozine (Fulfill) 50WG	2 ¾ oz	Do not apply more than 5½ oz/acre/year. Allow 7 days between applications.
	Thiamethoxam (Actara) 25 WDG	2 to 3 oz	Do not apply to tobacco already treated with Admire, Platinum or Provado. Apply only once during the growing season.

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

Insect	Insecticide and formulation	Rate per acre	Remarks and precautions
Budworms	Acephate (Orthene/ Acephate AG/ Address) 75S	1 lb (2 tbs/gal of water)	Apply as a spray.
	(Orthene) 97	¾ lb (1 ½ tbs/gal of water)	
	Bacillus thuringiensis (Agree) WG	1 to 2 lb	Apply as a spray. **Do not allow diluted sprays to stand more than 12 hours.**
	(Condor) OF	$^2/_3$ 1 $^2/_3$ qt	
	(Crymax) WG	½ to 1½ lb	
	(Dipel) DF	½ to 1 lb	
	(Ketch)	1 to 2 lb	
	(Lepinox) WDG	1 to 2 lb	
	(XenTari) WDG	½ to 1 lb	
	(Dipel) 10G	10 lb	Apply by hand or through properly calibrated mechanical ground equipment.
	(Dipel) SG Plus	5 to 10 lb	
	Carbaryl (Sevin) 80S	1 ¼ to 2 ½ lb	Apply as a spray. Do not apply until plants are established and growing. Aphids often become a problem on tobacco after two or more applications of Sevin.
	(Sevin XLR Plus) 4F	1 to 2 qt	

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

Insect	Insecticide and formulation	Rate per acre	Remarks and precautions
Budworms (cont'd)	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	
	Spinosad (Tracer) 4F	1½ to 2 fl oz	Use higher rates for large larvae or high infestation. Use at least 20 gal of water per acre.
Cabbage loopers	Acephate (Orthene Acephate AG/ Address) 75S	1 lb ((2 tbs/gal of water)	Apply as a spray in 10 to 50 gal of water
	(Orthene) 97	¾ lb (1 ½ tbs/gal)	
	Bacillus thuringiensis		Apply as a spray. **Do not allow prepared sprays to stand in tank more than 12 hrs.**
	See rates and formulations under budworms		
	Methomyl (Lannate) 90SP	½ lb	Apply as a spray. **Restricted Use.**
	(Lannate) 2.4 LV	1 ½ pt	
	Spinosad (Tracer) 4F	1½ to 2 fl oz	Apply as a spray in at least 20 gal of water per acre.

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

Insect	Insecticide and formulation	Rate per acre	Remarks and precautions
Cutworms	Acephate (Orthene/ Acephate AG/ Address) 75S	1 lb (2 tbs/gal)	Apply as a spray overtop of plants in affected areas when cutworms have injured 5% of the plants. Make application during late afternoon using at least 25 gal of spray per acre.
	(Orthene) 97	¾ lb (1 ½ tbs/gal)	
Flea beetles	Acephate (Orthene/ Acephate AG/ Address) 75S	⅔ lb (1 ½ tbs/gal of water)	Apply as a spray. Prime before treating
	(Orthene) 97	½ lb (1 tbs/gal)	
	Carbaryl (Sevin) 80S	1 ¼ lb (3 tbs/gal of water)	Apply as a spray. Do not apply until plants are established and growing. Aphids often become problems on tobacco following two or more applications of Sevin.
	(Sevin XLR Plus) 4F	1 qt	
	Endosulfan (Thiodan/ Golden Leaf Tobacco Spray/ Phaser) 3EC	⅔ to 1 ⅓ 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.**
	(Lannate) 2.4 LV	¾ to 1 ½ pt	
	Thiamethoxam (Actara) 25 WDG	2 to 3 oz	Do not apply to tobacco already treated with Admire, Platinum or Provado. Apply only once during the growing season.

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

Insect	Insecticide and formulation	Rate per acre	Remarks and precautions
Grass-hoppers	Acephate (Orthene/ Acephate AG/ Address) 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.
	(Orthene) 97	¼ to ½ lb	
	Carbaryl (Sevin) 80S	2/3 to 1 7/8 lb	
	(Sevin XLR Plus) 4F	½ to 1 ½ qt	
Hornworms	Acephate (Orthene/ Acephate AG/ Address) 75S	2/3 lb in water (1 ½ tbs/gal of water	Apply as a spray. Treat infested fields before worms are more than 1½ inches long. Direct insecticides toward the top six leaves of plants. Prime before treatment.
	(Orthene) 97	½ lb (1 tbs/gal)	
	Bacillus thuringiensis (Agree) WSP	1 to 2 lb	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).
	(Condor) OF	½ to 1 qt	
	(Crymax) WG	½ to 2 lb	
	(Dipel) DF	¼ to 1 lb	
	(Ketch) AF	1 to 2 lb	

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

Insect	Insecticide and formulation	Rate per acre	Remarks and precautions
Hornworms (cont'd)	(Lepinox) WDG	1 to 2 lb	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).
	XenTari WDG	½ to 1 lb	
	Carbaryl (Sevin) 80S	1 ¼ to 2 ½ lb (25 gal of water) (3 tbs/gal)	Apply as a spray.
	(Sevin XLR Plus) 4F	1 to 2 qt	
	Endosulfan (Thiodan/ Golden Leaf Tobacco Spray/ Phaser) 3EC	⅔ to 1 ⅓ qt	Apply as a spray. **Do not apply Endosulfan after topping. Highly toxic.**
	Methomyl (Lannate) 90SP	¼ to ½ lb in 25 gal of water	Apply as a spray. **Restricted Use.**
	(Lannate) 2.4 LV	¾ to 1 ½ pt	
	Spinosad (Tracer) 4F	1 to 2 fl oz	Apply as a spray in at least 20 gal of water per acre.
Japanese beetles	Carbaryl (Sevin) 80S	1 ¼ lb (3 tbs/gal of water).	Apply as a spray in at least 20 gal of water per acre. Damage is usually less severe than it appears.
	(Sevin XLR Plus) 4F	1 qt	
	Thiamethoxam (Actara) 25SG	2 to 3 oz	
	Imidacloprid (Provado) 1.6F	4 fl oz	

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

Insect	Insecticide and formulation	Rate per acre	Remarks and precautions
Stink bugs	Acephate (Orthene / Acephate AG/ Address) 75S	2/3 to 1 lb	Apply as a spray. **Do not apply endosulfan after topping. Endosulfan is highly toxic.** Stinkbug injury is usually much less severe than it appears.
	(Orthene) 97	½ to ¾ lb	
	Endosulfan (Thiodan/ Golden Leaf Tobacco Spray/ Phaser) 3EC	2/3 qt	
White-fringed beetles	No chemical controls		Cultural control: Rotate tobacco with grass crops. Control legumes and broadleaf weeds. **Do not plant tobacco after legumes.**

Insects on Stored Tobacco

Insect	Control	Remarks
Tobacco moths, cigarette beetles	Sanitation	Keep tobacco barns and packhouses free of tobacco debris and keep as dark as possible. Bulk barns are excellent for storage. Do not store tobacco near feed grain or seed. Do not store tobacco infested with tobacco moth or cigarette beetle. Sell all tobacco as soon as possible.

Insects on Stored Tobacco

Two insects, the tobacco moth and the cigarette beetle, commonly attack tobacco stored on the farm. Adult cigarette beetles are light to dark brown, hump-backed insects about 1/8 inch long. Adults leave tiny holes in the leaves as they emerge from pupal cases within the tobacco, but the larvae cause most of the damage. The hairy, C-shaped larvae are whitish with brown heads and are about 1/5 inch long. Problems with cigarette beetles are rare on farms in Virginia.

The tobacco moth is most serious on tobacco with high levels of sugars. Its larvae are pinkish to yellow to off-white caterpillars about ½ inch long. They burrow into and eat ragged holes in cured leaves. Entire leaves may be consumed except for the midrib and large veins. Larvae also deposit webbing and fecal pellets on infested tobacco. Adults, which do not feed on tobacco, are small gray moths about 3/8 inch long with a 5/8 inch wingspread.

Tobacco moths and cigarette beetles are most active from May through November. Cold weather between November and April inhibits their development and extreme cold (less than 32 °F) kills many overwintering larvae, especially cigarette beetle larvae.

Control - Sanitation is the most important method used to control cigarette beetles and tobacco moths on farms. Thoroughly clean the storage buildings before using them to store tobacco. Remove tobacco scraps and debris, feed, seed, and other plant and animal products that provide an initial source of infestation. Pay special attention to the removal of debris from walls, ceilings, cracks and crevices.

Store tobacco off the floor on pallets and cover it with a plastic sheet to keep it cool and dry and to help exclude insects. Promote good ventilation of the storage building. Check stored tobacco for insects every once 2 to 4 weeks from May through October. If you find the caterpillars of the tobacco moth, its webbing and feces, remove the infested tobacco from the pile, repack and treat the remaining tobacco with Dipel or XenTari to prevent reinfestation. If you find adult cigarette beetles or their C-shaped, hairy, larvae, remove the infested tobacco. Pheromone traps placed in the storage area can be used to warn growers when cigarette beetle and tobacco moth populations are becoming a problem. Do not use fumigants on tobacco stored on farm because they are hazardous and they can cause an off-flavor in the cured product.

HARVESTING, CURING, STRIPPING, AND MARKETING

Danny R. Peek, Extension Specialist, Burley Tobacco
James L. Jones, Extension Agronomist, Tobacco

Harvesting

Burley tobacco usually matures and is ready for harvest about 4 to 5 weeks after topping, at which time the upper 1/3 of the plant should have a distinct pale green to yellow appearance, and the bottom of the plant should be completely yellow. The midribs of the leaves should fade from a green color to a pale yellow color as the plant ripens. The amount of nitrogen fertilizer applied will have some influence on the time of maturity and, more directly, the quality of the tobacco at maturity. Growers are often hesitant to allow the upper leaves to ripen for fear of losing some of the lower leaves. However, added growth and weight of the upper leaves will usually more than make up for the loss of down-stalk leaves.

Currently there are several methods of cutting burley tobacco. Some growers allow the tobacco to be cut and placed in piles of 5-6 stalks, and then return to place this tobacco on a stick. Others use two person team, one cuts the plants and hands it back to the other person to spear the plant on the stick. The most efficient method is for one person to cut and spear the tobacco as they go through the field. However the tobacco is cut when speared onto a stick the tobacco should be turned so that the butts of the plants are towards the sun to minimize sunburn damage. Sunburnt tobacco can result in a cured leaf with a undesirable green color.

Tobacco should not be left in the field longer than 3 to 5 days unless it is scaffolded. It is especially important that the tobacco not be allowed to get muddy. Tobacco placed on scaffolds may be left in the field for up to 12 days with little or no damage from the weather and will lose about 40% in weight.

Curing

The curing of burley is not a simple drying process but involves a series of physical and chemical changes that begin when the plant is cut and ends when the plant is dry. The major steps include wilting, yellowing, browning or coloring, and drying. The entire process requires six to eight weeks.

Optimum curing conditions occur when temperature is in the general range of 60-90^{0}F and relative humidity is 65-70%. In the early stages of curing, it is impractical to attempt to maintain these optimum ranges through a 24-hour period. In normal weather, the humidity within a barn filled with green tobacco will approach 100% each night. A good cure can still be obtained if ventilation is provided to dry out the barn the next day.

Houseburn may be a problem in curing burley. It may be called many other names such as barn rot, pole sweat, stem mold, leaf rot, and others; but it is a partial decay of tobacco tissue during the curing process. It is caused by several species of fungi and bacteria that are present on tobacco leaves. Injury occurs when these micro-organisms attack leaves that become moist during periods of high humidity that last longer than 24 hours. Damage can be measured in weight loss and lowered leaf quality and can range from mild to severe. Symptoms include a white or gray mold and an odor of rotting tobacco. Injury is worse on the lower tiers and on the leeward side of the barn.

Supplemental heat can be an advantage during rainy weather or prolonged periods of high humidity. The objective in using heat is to raise the temperature within the barn only 6-8^{0}F or just enough to dry the leaf surface and thereby prevent the proliferation of organisms that cause houseburn. Some type of heat spreader should be used on burners to prevent hot spots that can set undesirable colors in the curing leaf.

Maximum temperature increases should not exceed 10-15°F. Heat can also be used to prevent setting green color by freezing on freshly harvested late-cut tobacco.

Many curing problems can be relieved or prevented by proper manipulation of barn equipment. Generally, ventilators and doors should be open during fair weather and closed during rainy weather and at night. This process can be reversed during extremely dry weather when tobacco is curing too fast. New barns should be located on high ground with good air circulation and with the long side exposed to prevailing winds.

Much tobacco in Virginia is cured on some type of field-curing structure. The curing environiment is managed primarily by stick spacing and cover management. Stick spacing should be much closer in this type of structure, approximately 4 inches. **All Curing structures should be covered.** Curing burley tobacco without cover reduces quality and yield of cured leaf. A general recommendation would be to leave the sides of the cover up during the yellowing stage of curing and then lower the sides for the rest of the curing process. An exception would be during hot dry conditions the sides should be lowered during the day to slow down the curing process. Tobacco should be removed from the field-curing structure as soon as possible after the curing process is completed. This will minimize damage due to weather, primarily wind.

Stripping and Marketing

Stripping the leaves from the stalk and sorting into groups enables leaf buyers to obtain the specific grades needed by the manufacturer. The one priced market in the early 1990's resulted in much of our burley being graded into one or two grades. The biggest advantage we have in U.S. burley production is quality. If not properly separated by stalk position, quality is sacrificed and the overall sustainability of burley production in Virginia is weakened.

Generally there are four distinguishable grades of tobacco on a stalk. These grades include Flyings (X), Lugs (C), Leaf (B), and Tips (T). The flyings group (X) consists of leaves grown at the bottom of the stalk. These leaves are flat and have a blunt of oblate tip. They are relatively thin bodied and show a certain amount of injury. The lug group (C) consists of leaves which grow above the flyings and up to about midportion of the stalk. These leaves have a rounded tip and , when cured have a tendency to fold and conceal the midrib. They are thin to medium bodied. The leaf group (B) is made up of leaves grown above the lugs. The cured leaves, especially from the upper stalk position, have a tendency to fold and conceal the face of the leaf. These leaves are medium to heavy bodied. The tips (T) are those top 3 or 4 leaves at the top of the stalk. They have same general characteristics of the leaf group. The practice of mixing grades may offer a slight labor savings, but it does not meet the needs of most buyers. With an over-supply situation and a weak market, mixed tobacco generally sells for less than properly sorted good quality leaf. Three groups is the least number that should be used in preparing any burley crop for market. Currently much of the burley purchased in Virginia is purchased through a contract rather than the auction system. Currently, many manufactures prefer four grades. Frequently, there will be no leaves in a crop short enough to grade in the tip (T) group. Buyers complained about a shortage of tip grades available from recently marketed crops. Generally there will be enough difference in color and body in upstalk tobacco to warrant a separation into bright leaf and red leaf.

Tobacco should not be stripped or baled in too high or too low moisture content. Dry leaf lamina is easily shattered and ruins the usability of the leaf. High moisture tobacco will easily over-heat and mold and will damage in handling. It has also been proven that tobacco stored at a high Moisture level results in higher levels of tobacco specific nitrosamines (TSNA's). Moisture content should be between 18 and 22% for proper handling and storage.

EPA Worker Protection Standards for Commonly Used Pesticides for Burley Tobacco 2002

Danny R. Peek, Extension Specialist, Burley Tobacco
Charles Johnson, Extension Plant Pathologist, Tobacco
T. David Reed, Extension Agronomist, Tobacco
Paul J. Semtner, Extension Entomologist, Tobacco
Virginia Tech

J. Michael Moore
Extension Agronomist (Tobacco)
University of Georgia Cooperative Extension Service

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

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

The following table lists products, registration numbers, common names, restricted entry intervals, and posting/notification requirements for commonly used pesticides and growth regulators labeled for tobacco. **Remember, however, that the information in this table is presented in good faith as a reference only**. This information does not take the place of the product label; changes to label information can occur without notice. ***Always read and follow label directions.***

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

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2] Applicators and Other Handlers	To Enter Treated Area Within REI[3]	Worker Notification Oral	Posted
Acephate ® 75SP AG (acephate) EPA Reg. No. 51036-236 Micro Flo **Address ® 75WSP** (acephate) EPA Reg. No. 750506-1-707 Dow AgroSciences	Caution	24 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks; chemical resistant headgear for overhead exposure	coveralls; waterproof gloves; shoes plus socks; chemical resistant headgear for overhead exposure	either	either
Acrobat MZ (demethomorph and mancozeb) EPA Reg. No. 241-383;SLN No. VA990003 BASF Corp.	Caution	24 hrs.	coveralls over long sleeved shirt and long pants; chemical-resistant gloves made of any waterproof material; shoes plus socks; protective eyewear; chemical-resistant apron when cleaning equipment, mixing or loading; dust/mist filtering respirator or a NIOSH approved respirator with any N, R, P or HE filter	coveralls over long-sleeved shirt and long pants; chemical-resistant glovers made of any waterproof material; shoes plus socks	either	either
Actara 25 WDG (thiamethoxam) EPA Reg. No. 100-938 Syngenta	Caution	12 hrs.	long-sleeved shirt, waterproof glovers, shoes plus socks	coveralls, waterproof gloves, shoes plus socks	either	either

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2] Applicators and Other Handlers	To Enter Treated Area Within REI[3]	Worker Notification Oral	Posted
Actigard 50WG (acibenzolar-s-methyl) EPA Reg. No. 100-922 Syngenta Crop Protection	Caution	12 hrs	long-sleeved shirt and long pants; chemical resistant gloves made of any waterproof material such as polyethylene; shoes plus socks	coveralls; chemical-resistant gloves made of any waterproof material such as polyethylene or polyvinyl chloride; shoes plus socks	none	none
Admire® 2 Flowable (imidacloprid) EPA Reg. No. 3125-422 Bayer	Caution	12 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either
Agree® *(Bacillus thuringiensis var. aizawai* strain) EPA Reg. No. 100-733 Thermo Trilogy	Caution	4 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks; protective eyewear; dust/mist filtering respirator	coveralls; waterproof gloves; shoes plus socks; protective eyewear	either	either
Antak® (C10 fatty alcohol) EPA Reg. No. 19713-18 Drexel	Warning	24 hrs.	coveralls over short-sleeved shirt and short pants; waterproof gloves; chemical-resistant footwear plus socks; protective eyewear; chemical-resistant headgear for overhead exposure; chemical-resistant apron when cleaning equipment, mixing or loading	coveralls over short-sleeved shirt and short pants; waterproof gloves; chemical-resistant footwear plus socks; protective eyewear; chemical-resistant headgear for overhead exposure	either	either

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2] Applicators and Other Handlers	To Enter Treated Area Within REI[3]	Worker Notification Oral	Posted
Brom-O-Gas® (98% methyl bromide) EPA Reg. No. 5785-4, -42 Great Lakes Chemical	Danger	48 hrs. and gas concentration less than 5 ppm	loose fitting or well ventilated long-sleeved shirt and long pants; shoes and socks; fullface shield or safety glasses with brow and temple shields	non-handlers prohibited	yes	yes
Butralin (butralin) EPA Reg. No. 33688-4-400 Uniroyal	Danger	12 hrs.	long-sleeved shirts and long pants; chemical-resistant gloves; shoes and socks; and protective eyewear	coveralls; chemical-resistant gloves; shoes and socks; and protective eyewear	either	either
Chlor-O-Pic® (99% chloropicrin) EPA Reg. No. 5785-17 Great Lakes Chemical **Chloropicrin 100®** EPA Reg. No. 8536-02-8853 Hendrix and Dail, Inc.	Danger	48 hrs. and gas concentration less than 0.1 ppm	loose fitting or well ventilated long-sleeved shirt and long pants; shoes and socks; fullface shield or safety glasses with brow and temple shields. Do not wear goggles.	non-handlers prohibited	yes	yes
Command® 4 EC (clomazone) EPA Reg. No. 279-3053 FMC	Warning	12 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves, such as Barrier Laminate or Viton; shoes plus socks; and protective eyewear	coveralls; chemical-resistant gloves, such as Barrier Laminate or Viton; shoes plus socks; and protective eyewear	either	either
Command ® 3ME EPA Reg. No. 279-3158 FMC	Warning	12 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves, such as Barrier Laminate or Viton; shoes plus socks; and protective eyewear	coveralls; chemical-resistant gloves, such as Barrier Laminate or Viton; shoes plus socks; and protective eyewear	either	either

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2] Applicators and Other Handlers	 To Enter Treated Area Within REI[3]	Worker Notification Oral	 Posted
Condor® (*Bacillus thuringiensis* subspecies *kurstaki* strain EG 2348) EPA Reg. No. 55638-7 Ecogen **Condor® XL** (*Bacillus thuringiensis* subspecies *kurstaki* strain EG 2348) EPA Reg. No. 55638-33 Ecogen	Caution	4 hrs.	long-sleeved shirt and long pants; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either
Crymax® (*Bacillus thuringiensis*) EPA Reg. No. 55638-34 Ecogen	Caution	4 hrs.	long-sleeved shirt and long pants; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either
Devrinol ® 2-E (napropamide) EPA Reg. No. 10182-219-70506 United Phosphorus, Inc.	Danger	12 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves, such as barrier laminate or Viton ≥ 14 mils; shoes plus socks; protective eyewear	coveralls; chemical resistant gloves, such as barrier laminate or Viton ≥ 14 mils; shoes plus socks; protective eyewear	either	either
Devrinol® 50-DF (napropamide) EPA Reg. No. 10182-258-70506 United Phosphorus, Inc.	Caution	12 hrs.	long-sleeved shirt and long pants; waterproof gloves, shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either
Dipel® 10G (*Bacillus thuringiensis*) EPA Reg. No. 275-55 Valent	Caution	4 hrs.	long-sleeved shirt and long pants; shoes plus socks	coveralls; shoes plus socks; waterproof gloves	either	either

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2] Applicators and Other Handlers	 To Enter Treated Area Within REI[3]	Worker Notification Oral	 Posted
Dipel® ES (*Bacillus thuringiensis*) EPA Reg. No. 73049-17 Valent	Caution	4 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either
Dipel® DF (*Bacillus thuringiensis*) EPA Reg. No. 275-103 Valent	Caution	4 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either
Dipel ®SG Plus (*Bacillus thuringiensis*) EPA Reg. No. 275-96 Valent	Caution	4 hrs.	long-sleeved shirt and long pants; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either
Di-Syston® 15 G (disulfoton) EPA Reg. No. 3125-172 Bayer	Danger	48 hrs.	coveralls over short-sleeved shirt and short pants; waterproof gloves; chemical-resistant footwear plus socks; chemical-resistant headgear; chemical-resistant apron; respirator	coveralls over short-sleeved shirt and short pants; waterproof gloves; chemical-resistant footwear plus socks; chemical-resistant headgear for overhead exposure	yes	yes
Dithane® DF Rainshield (mancozeb) EPA Reg. No. 707-180 SLN No. VA 940001 Dow AgroSciences	Caution	24 hrs.	coveralls over long-sleeved shirt and long pants; chemical resistant gloves such as butyl rubber or nitrile rubber or neoprene rubber or Viton; shoes plus socks; chemical-resistant apron when cleaning equipment, mixing or loading	coveralls over long-sleeved shirt and long pants; chemical resistant gloves, such as butyl rubber or nitrile rubber or neoprene rubber or Viton; shoes plus socks; protective eyewear	either	either

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2] Applicators and Other Handlers	To Enter Treated Area Within REI[3]	Worker Notification Oral	Posted
Fair 85® (C6, - C12 fatty alcohols) EPA Reg. No. 51873-7 Fair Products	Warning	24 hrs.	long-sleeved shirt and long pants; chemical resistant gloves such as barrier laminate or butyl rubber or nitrile rubber or neoprene or polyvinyl chloride or Viton; shoes plus socks; protective eyewear	coveralls; chemical resistant gloves such as barrier laminate or butyl rubber or nitrile rubber or neoprene or polyvinyl chloride or Viton; shoes plus socks; protective eyewear	either	either
Fair Plus® (maleic hydrazide) EPA Reg. No. 51873-2 Fair Products	Caution	12 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks; protective eyewear	coveralls; waterproof gloves; shoes plus socks; protective eyewear	either	either
Fair-30® EPA Reg. No. 51873-9 Fair Products **Fair 80 SP®** EPA Reg. No. 51873-17	Caution	12 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks; protective eyewear	coveralls; waterproof gloves; shoes plus socks; protective eyewear	either	either
FST-7® (C10 fatty alcohol and maleic hydrazide) EPA Reg. No. 51873-6 Fair Products	Danger	24 hrs.	long-sleeved shirt and long pants; chemical resistant gloves such as Barrier Laminate or butyl rubber or nitrile rubber or neoprene or polyvinyl chloride or Viton; shoes plus socks; protective eyewear	coveralls; chemical resistant gloves such as Barrier Laminate or butyl rubber or nitrile rubber or neoprene or polyvinyl chloride or Viton; shoes plus socks; protective eyewear	either	either
Fulfill® 50WDG (pymetrozine) EPA Reg. No. 100-192 Syngenta	Caution	12 hrs.	long-sleeved shirt and long pants, waterproof gloves, shoes plus socks	long-sleeved shirt and long pants, waterproof gloves, shoes plus socks	either	either

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2] Applicators and Other Handlers	To Enter Treated Area Within REI[3]	Worker Notification Oral	Posted
Furadan® 4 F (carbofuran) EPA Reg. No. 279-2876 FMC	Danger	48 hrs.	long-sleeved shirt and long pants; chemical resistant gloves such as Barrier Laminate or butyl rubber or nitrile rubber or neoprene or polyvinyl chloride or Viton; shoes plus socks; protective eyewear when mixing or loading; respirator; when using closed systems, enclosed cabs or aircraft in a manner that meets WPS requirements the PPE requirements may be reduced or modified	coveralls; chemical resistant gloves; shoes plus socks	yes	yes
Golden Leaf Tobacco Spray® (endosulfan) EPA Reg. No. 279-2924 FMC **Phaser ®** EPA Reg. No. 8340-14-54382 Arg Evo **Thiodian ® 3EC** EPA Reg. No. 279-2924 FMC	Danger	24 hrs.	long-sleeved shirt; trousers; unlined waterproof gloves made of natural rubber or neoprene; full foot covering (such as shoes or boots); head covering (such as a hat; and a pesticide mask or respirator jointly approved by the Mine Safety and Health Administration (MSHA) and the National Institute for Occupational Safety and Health (NIOSH) under the provisions of 30 CFR Part 11 for protection against endosulfan. Mixers and/or loaders must wear a chemical resistant apron and goggles or face shield in addition to all the protective equipment specified for applicators	a hat or other suitable head covering; a long-sleeved shirt and long legged trousers or a coverall type garment (all of closely woven fabric covering the body, including the arms and legs), shoes and socks	either	either

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2] Applicators and Other Handlers	To Enter Treated Area Within REI[3]	Worker Notification Oral	Posted
Ketch DF (*bacillus thuringiensis*) EPA Reg. No. 70051-47-707 Dow AgroSciences	Caution	4 hrs.	long-sleeved shirt, waterproof gloves, shoes plus socks, protective eyewear	coveralls, waterproof gloves, shoes plus socks	either	either
Lannate® SP (methomyl) EPA Reg. No. 352-342 DuPont	Danger	48 hrs.	long-sleeved shirts and long legged pants; waterproof gloves; shoes plus socks; protective eyewear; exposure outdoors mist/dust filtering respirator (MSHA/NIOSH approval no. prefix TC-21C).	coveralls; waterproof gloves; shoes plus socks, protective eyewear	either	either
Lannate® L (methomyl) EPA Reg. No. 352-370 **Lannate® LV** EPA Reg. No. 352-384 DuPont	Danger	48 hrs.	long-sleeved shirts and long legged pants; chemical-resistant gloves; shoes plus socks; protective eyewear; exposure outdoors mist/dust filtering respirator	coveralls; chemical-resistant gloves; shoes plus socks, protective eyewear	either	either
Leven-38® (C10 fatty alcohol and maleic hydrazide) EPA Reg. No. 19713-105 Drexel	Danger	24 hrs.	coveralls over short-sleeved shirt and short pants; waterproof gloves; chemical-resistant footwear plus socks; protective eyewear; chemical-resistant headgear for overhead exposure; chemical-resistant apron when cleaning equipment, mixing or loading	coveralls over short-sleeved shirt and short pants; chemical-resistant footwear plus socks; protective eyewear, chemical-resistant headgear for overhead exposure	either	either

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2] Applicators and Other Handlers	To Enter Treated Area Within REI[3]	Worker Notification Oral	Posted
Lorsban® 4E (chlorpyrifos) EPA Reg. No. 62719-220 Dow AgroSciences	Warning	24 hrs.	long-sleeved shirt and long pants; chemical resistant gloves; shoes plus socks	coveralls; chemical-resistant gloves; shoes plus socks	yes	NR
Mocap® EC (ethoprop) EPA Reg. No. 264-458 Aventis CropScience	Danger	48 hrs.	chemical resistant suit; chemical resistant gloves such as barrier laminate, butyl rubber, nitrile rubber or Viton, chemical resistant footwear plus socks; protective eyewear; chemical resistant headgear for overhead exposures; organic vapor-removing or canister respirator (MSHA/NIOSH approved)	chemical resistant suit; chemical resistant gloves such as barrier laminate, butyl rubber , nitrile rubber or Viton; chemical resistant footwear plus socks; protective eyewear; chemical resistant headgear for overhead exposures	yes	yes
Nemacur® 3EC (fenamiphos) EPA Reg. No. 3125-283 Bayer	Danger	48 hrs.	chemical-resistant protective suit; chemical-resistant gloves; such as barrier laminate or Viton, chemical-resistant footwear plus socks; protective eyewear; chemical-resistant headgear for overhead exposure; dust/mist filtering respirator	chemical-resistant protective suit; chemical-resistant gloves; such as barrier laminate or Viton; chemical-resistant footwear plus socks; protective eyewear; chemical-resistant headgear for overhead exposure	either	either

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2] Applicators and Other Handlers	 To Enter Treated Area Within REI[3]	Worker Notification Oral	 Posted
Off-Shoot T® (C6 - C12 fatty alcohols) EPA Reg. No. 57582-3 Cochran	Warning	24 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks; protective eyewear	coveralls; waterproof gloves; shoes plus socks; protective eyewear	either	either
Orthene® 75 S (acephate) EPA Reg. No. 59639-26AA **Orthene ® 97** EPA Reg. No. 59639-91 Valent	Caution	24 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks; chemical resistant headgear for overhead exposure	coveralls; waterproof gloves; shoes plus socks; chemical resistant headgear for overhead exposure	either	either
Phaser®	SEE "GOLDEN LEAF TOBACCO INSECT SPRAY"					
Platinum ® 2SC (thiamethoxam) EPA Reg. No. 100-939 Syngenta	Caution	12 hrs.	long-sleeved shirt, waterproof gloves, shoes plus socks	coveralls, shirt, waterproof, gloves, shoes plus socks	either	either
Poast® (sethoxydim) EPA Reg. No. 7969-58 SLN No. VA-980004 BASF Corp.	Warning	12 hrs.	chemical resistant gloves; coveralls over short-sleeved shirt and short pants; chemical resistant footwear plus socks; protective eyewear; chemical resistant headgear for overhead exposure; Other - chemical resistant apron when cleaning equipment mixing and loading	chemical resistant gloves; coveralls over short-sleeved shirt and short pants; chemical resistant footwear plus socks; protective eyewear; chemical resistant headgear for overhead exposure; Other - chemical resistant apron when cleaning equipment mixing and loading	either	either

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2] Applicators and Other Handlers	To Enter Treated Area Within REI[3]	Worker Notification Oral	Posted
Prep® (ethephon) EPA Reg. No. 264-418 Aventis Cropscience	Danger	48 hrs.	coveralls over short-sleeved shirt and short pants; waterproof gloves; protective eyewear; chemical resistant footwear plus socks; chemical resistant headgear for overhead exposures; chemical resistant apron when cleaning equipment	coveralls over short-sleeved shirt and short pants; waterproof gloves; protective eyewear; chemical resistant footwear plus socks; chemical resistant headgear for overhead exposures	yes	yes
Provado 1.6F ® (imidacloprid) EPA Reg. No. 3125-457 Bayer	Caution	12 hrs.	long-sleeved shirt and long pants, waterproof gloves; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either
Prowl® 3.3 (pendimethalin) EPA Reg. No. 241-337 BASF Corp.	Caution	12 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves; shoes plus socks	coveralls; chemical-resistant gloves; shoes plus socks	either	either
Ridomil Gold EC ® (mefenoxam) EPA Reg. No. 100-801 Syngenta	Warning	48 hrs.	long-sleeved and long pants, chemical-resistant gloves, shoes plus socks, protective eyewear	coveralls, chemical-resistant gloves, shoes plus socks, protective eyewear	none	none

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2] Applicators and Other Handlers	To Enter Treated Area Within REI[3]	Worker Notification Oral	Posted
Royal MH-30® (maleic hydrazide) EPA Reg. No. 400-84 **Royal MH-30® SG** EPA Reg. No. 400-165 **Royal MH-30® XTRA** EPA Reg. No. 400-452 Uniroyal	Caution	12 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either
Sevin® 4F (carbaryl) EPA Reg. No. 264-349 **Sevin® XLR Plus** EPA Reg. No. 264-333 Aventis CropScience	Caution	12 hrs	long-sleeved shirt and long pants; chemical resistant gloves such as Barrier Laminate, butyl rubber, nitrile rubber, neoprene rubber, polyvinyl chloride (PVC), or Viton; shoes plus socks and chemical-resistant headgear for overhead exposure	coveralls; chemical resistant gloves such as Barrier Laminate, butyl rubber, nitrile rubber, neoprene rubber, polyvinyl chloride (PVC), or Viton; shoes plus socks and chemical-resistant headgear for overhead exposure	either	either
Sevin® 50W (carbaryl) EPA Reg. No. 264-314 **Sevin® 80S** Aventis CropScience	Warning	12 hrs	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks and chemical-resistant headgear for overhead exposure	coveralls; waterproof gloves; shoes plus socks and chemical-resistant headgear for overhead exposure	either	either

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2] Applicators and Other Handlers	To Enter Treated Area Within REI[3]	Worker Notification Oral	Posted
Spartan ® (sulfentrazone) EPA Reg. No. 279-3189 **Spartan ® 4F** EPA Reg. No. 279-3220 FMC Corp.	Caution	12 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks	coveralls over long-sleeved shirt and long pants; water-proof gloves; shoes plus socks	either	either
Sucker Plucker® (C6 - C12 fatty alcohols) EPA Reg. No. 19713-35 Drexel	Warning	24 hrs.	coveralls over short-sleeved shirt and short pants; waterproof gloves; protective eyewear; chemical resistant footwear plus socks; chemical resistant headgear for overhead exposure; chemical resistant apron when cleaning equipment, mixing or loading	coveralls over short-sleeved shirt and short pants; waterproof gloves; protective eyewear; chemical resistant footwear plus socks; chemical resistant headgear for overhead exposure	either	either
Sucker Stuff® (maleic hydrazide) EPA Reg. No. 19713- **Super Sucker Stuff®** EPA Reg. No. 19713-20 Drexel	Caution	12 hrs.	long-sleeved shirt and long pants; shoes plus socks; waterproof gloves	coveralls; waterproof gloves; shoes plus socks	either	either
Sucker Stuff® 60 WS (maleic hydrazide) EPA Reg. No. 19713-371 Drexel	Caution	12 hrs.	long-sleeved shirt and long pants; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2] Applicators and Other Handlers	To Enter Treated Area Within REI[3]	Worker Notification Oral	Posted
Telone® C-17 (1,3-Dichloropropene and Chloropicrin) EPA Reg.No. 62719-32 Dow AgroSciences	Danger	5 days	Not inside an enclosed cab: coveralls over short-sleeved shirt and short pants; chemical-resistant gloves; chemical-resistant footwear plus socks; face sealing goggles, unless full-face respirator is worn; chemical-resistant headgear for overhead exposure; full-face respirator with an organic-vapor-removing cartridge. In enclosed cabs: coveralls; shoes and socks; and a full-face respirator. A respirator is not required if the occupants are within an enclosed cab that is in conformance with one of the following: 1) ASAE Standard S525 sections 7.1.5, 7.1.7, 7.2.3, and 9, or 2) the requirements listed in the WPS for agricultural pesticides - 40 CFR 170.240 (d)(5). The cab must be equipped with a vapor-adsorptive filter containing a min. of 1000 grams activated charcoal.	Only the following handler tasks may be performed in the treated area within the 5 days after the application is complete: assessing/adjusting the soil seal; assessing pest control, application technique, or application efficacy; and sampling air or soil for this product. Unless in an enclosed cab, handlers in the treated area within 5 days after application must wear: coveralls; chemical-resistant gloves; chemical-resistant footwear and socks; and a full-face respirator.	yes	yes

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE) [2] Applicators and Other Handlers	 To Enter Treated Area Within REI [3]	Worker Notification Oral	 Posted
Telone® II (1,3-Dichloropropene) EPA Reg. No. 62719-32 Dow AgroSciences	Warning	5 days	Not inside an enclosed cab: coveralls over short-sleeved shirt and short pants; chemical-resistant gloves; chemical-resistant footwear plus socks; face sealing goggles, unless full-face respirator is worn; chemical-resistant headgear for overhead exposure; a respirator with an organic-vapor-removing cartridge. In enclosed cabs: coveralls; shoes and socks; and a half-face respirator. A respirator is not required if the occupants are within an enclosed cab that is in conformance with one of the following: 1) ASAE S525 sections 7.1.5, 7.1.7, 7.2.3, and 9, or 2) the req. listed in the WPS for agri. pesticides -- 40 CFR 170.240 (d)(5). The cab must be equipped with a vapor-adsorptive filter containing a min. 1000 g activated charcoal.	Only the following handler tasks may be performed in the treated area within the 5 days after the application is complete: assessing/adjusting the soil seal; assessing pest control, application technique, or application efficacy; and sampling air or soil for this product. Unless in an enclosed cab, handlers in the treated area within 5 days after application must wear: coveralls; chemical-resistant gloves; chemical-resistant footwear and socks; and a respirator.	yes	yes

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2] Applicators and Other Handlers	To Enter Treated Area Within REI[3]	Worker Notification Oral	Posted
Terramaster 35WP (etridiazole) EPA Reg. No. 400-416 **Terramaster 4EC** (etridiazole) EPA Reg. No. 400-422 Uniroyal	Warning	12 hrs.	long-sleeved shirt and long pants, shoes plus socks, protective eyewear, dust/mist filtering respirator or a NIOSH approved respirator with any N, R, P, or HE filter	coveralls, waterproof gloves, shoes and socks, protective eyewear	none	none
Terr-O-Gas® (67% methyl bromide, 33% chloropicrin) EPA Reg. No. 5785-17 Great Lakes Chemical **Tri-Con 67/33** EPA Reg. No. 11220-07-8853 Hendrix and Dail, Inc.	Danger	48 hrs. and gas concentration less than 5 ppm (methyl bromide) and 0.1 ppm chloropicrin	loose fitting or well ventilated long-sleeved shirt and long pants; shoes and socks; fullface shield or safety glasses with brow and temple shields	non-handlers prohibited	yes	yes
Thiodan® 3EC 50 WP SEE "GOLDEN LEAF TOBACCO INSECT SPRAY"						
Tillam® 6E (pebulate) EPA Reg. No. 73637-56077 Cedar Chemical Corporation	Caution	12 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves, such as barrier laminate or nitrile rubber or neoprene rubber or Viton; shoes plus socks; protective eyewear	coveralls; chemical-resistant gloves, such as barrier laminate or nitrile rubber or neoprene rubber or Viton; shoes plus socks; protective eyewear	either	either

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2] Applicators and Other Handlers	To Enter Treated Area Within REI[3]	Worker Notification Oral	Posted
Tracer® 4 EPA Reg. No. 62719-267 Dow AgroSciences	Caution	4 hrs.	long-sleeved shirt and long pants; shoes plus socks; waterproof gloves	coveralls; waterproof gloves; shoes plus socks	either	either
Ultra Flourish (mefenoxam) EPA Reg. No. 55146-73 Nufarm Americas, Inc.	Warning	12 hrs.	long-sleeved shirt and long pants, chemical-resistant gloves, shoes plus socks, protective eyewear	coveralls, chemical-resistant gloves, shoe plus socks, protective eyewear	none	none
Vapam HL ® (metam sodium) EPA Reg. No. 5481-468 AMVAC **Metam CLR®** EPA Reg. No. 45728-16 UCB Chemicals Corp. **Sectagon 42®** EPA Reg. No. 61842-6 Tessenderlo Kerley, Inc.	Warning	48 hrs.	coveralls over long-sleeved shirt and long pants; waterproof gloves; chemical-resistant footwear plus socks; chemical-resistant headgear for overhead exposure; chemical-resistant apron when cleaning equipment, or when mixing, loading, or transferring without dry-disconnect fittings; face-sealing goggles, unless full-face respirator is worn; a respirator with either an organic-vapor-removing cartridge with a prefilter approved for pesticides or canister approved for pesticides	While entry is restricted only the following handling tasks may be performed in a treated area: assessing/adjusting the soil seal; assessing pest control, application technique, or application efficacy; sampling air or soil for this period. **All other tasks are prohibited until the entry restriction is over.** Handlers performing the above tasks must wear: coveralls over long-sleeved shirt and long pants; waterproof gloves; chemical-resistant footwear plus socks. **Plus handlers must wear if pungent, rotten egg odor of this product can be detected:** face-sealing goggles, unless full-face respirator is worn; a respirator with either an organic-vapor-removing cartridge with a prefilter approved for pesticides or canister approved for pesticides.	yes	yes

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2] Applicators and Other Handlers	To Enter Treated Area Within REI[3]	Worker Notification Oral	Posted
Vydate® L (oxamyl) EPA Reg. No. 352-372 Du Pont	Danger	48 hrs.	coveralls over short-sleeved shirt and short pants; chemical-resistant gloves, such as Barrier Laminate or butyl rubber or neoprene rubber or polyvinyl chloride (PVC) or Viton or nitrile rubber; chemical-resistant footwear plus socks; protective eyewear; chemical-resistant headgear for overhead exposure; chemical-resistant apron when cleaning equipment, mixing, or loading; respirator with either an organic-vapor-removing cartridge with a prefilter approved for pesticides or canister approved for pesticides	coveralls over short-sleeved shirt and short pants; chemical-resistant gloves, such as Barrier Laminate or butyl rubber or neoprene rubber or polyvinyl chloride (PVC) or Viton or nitrile rubber; chemical-resistant footwear plus socks; protective eyewear; chemical-resistant headgear for overhead exposure	either	either
XenTari® WDG (*Bacillus thuringiensis*) EPA Reg. No. 275-85 Valent	Caution	4 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks; dust/mist filtering respirator (MSHA/NIOSH approved number prefix TC-21C)	coveralls; waterproof gloves; shoes plus socks	either	either

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

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

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

Extension Personnel Working With Burley Tobacco

The following are the county Extension Service personnel with burley tobacco responsibility as of January 1, 2002.

County	Name	Telephone
Bland	Scott Jerrell	276-688-3542
Dickenson	Brad Mullins	276-926-4605
Grayson	Jimmy Osborne	276-773-2491
Lee	Harold Jerrell	276-346-1522
Russell	Paul Chambers	276-889-8056
Scott	Mike Cassell	276-452-2772
Smyth	Walter Robinson	276-783-5175
Washington	Phil Blevins	276-676-6309

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BURLEY TOBACCO PRODUCTION GUIDE

Prepared By:

Danny R. Peck	Extension Specialist, Tobacco
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

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