2008 BURLEY TOBACCO PRODUCTION GUIDE

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2008 Burley Tobacco Production Guide

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Disclaimer:

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Agronomic Practices

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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, purchase only certified disease-free transplants.

Below is an outline of plant-bed management practices that have proven effective over the years. If you follow these suggestions, 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 the plant bed area needed to 60 to 80 square yards per acre).
3. Prepare a good seedbed. The soil should be well pulverized, smooth, and free of clods. Avoid flat and saucer-shaped beds. To assure good surface drainage, use a moldboard plow to break the beds to the center so that the center of the bed is 2 to 3 inches higher than the surrounding area. In the later stages of plant-bed preparation, do not use heavy equipment that will tend to pack the soil.
4. Fumigate soil with methyl bromide when the soil moisture is right for cultivation and the air temperature is 55°F or higher, preferably in the fall.
5. Apply 50 pounds of 12-6-6 fertilizer per 100 square yards and disc into the top 2 to 3 inches of soil. If extra nitrogen is needed, you can use 3 to 6 pounds of calcium nitrate (15.5-0-0) per 100 square yards as a top dressing. To avoid plant injury and possible loss of transplants, do not use organic forms of nitrogen on plant beds.
6. Sow 1/6 to 1/8 ounce of seed per 100 square yards, cover with a thin layer of straw, and place cover directly on straw (15 to 20 pounds of straw per 100 square yards).

7. In dry weather, frequently water beds covered with porous materials (Reemay, cotton, etc.). 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. Apply water slowly enough so that it is absorbed and the force of the water does not dislodge the seedlings. Water plant beds 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 4 inches and ending at a height of 8 inches to improve plant uniformity and/or delay plant growth. Clip approximately 1/2 inch above the bud of the largest plants.

The lack of sufficient water is perhaps the most frequent cause of an inadequate plant-bed stand and transplant shortage. Moisture is particularly necessary for seed germination and seedling establishment. Natural rainfall often is 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 pounds of Epsom salts per 100 square yards or 3 pounds per 100 square yards of Sul-Po-Mag. You may also use potassium sulfate at a rate of 3 pounds per 100 square yards 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 feet 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 ensure 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 specific seed spacing. Commercial seed companies are now marketing most of the popular varieties as pelleted seed. The Stanhay Precision planter has been used most frequently and has given good results.

Clipping Plants

Clipping (removing a portion of the leaves above the bud) has been shown to increase uniformity among plants and increase the percentage of usable plants in a bed. Removing leaves from the larger plants permits light to penetrate 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 the excessive growth of plants in the bed during adverse field conditions. Two clippings spaced four to five days apart can delay transplanting by seven to ten days.

You can clip with a modified high suction lawn mower or a tractor-mounted rotary mower with rear-mounted gauge wheels. Tractor-mounted mowers work best on narrow (6 feet wide) raised plant beds, but can be used on wide (15 feet) 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 four to five 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, loosens the soil around plant roots and makes pulling easier and faster. Research conducted at North Carolina State University by R.C. Long showed that pulling labor can be reduced by 50 percent to 60 percent 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 feet wide) is suggested where undercutting will be used.

VARIETIES

Danny R. Peek, Extension Specialist, Burley Tobacco

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Selecting the right burley tobacco variety for your farm is one of the most important decisions you make in producing a profitable crop. Individual farmers have different requirements for the variety or varieties grown on their farm. Consider your requirements for disease resistance, yield potential, ease of growing, maturity, curing, and market acceptance when selecting a burley tobacco variety. Another important consideration for growers in the piedmont area of Virginia is holding ability. Many of the burley varieties commonly grown in the traditional burley area of Virginia begin to decline in yield four weeks after topping in the piedmont area. So a variety that can stand longer from topping to harvest and continue to increase, and not decrease, in yield is desirable.

The most important factor to consider when selecting a burley tobacco variety is the disease history of the farm where tobacco will be grown. Diseases such as black shank, blue mold, black root rot, and virus complexes are the diseases that result in the most significant yield losses for burley tobacco. For all these disease problems there is some level of varietal resistance. However, no one variety currently has total resistance to the combination of all these diseases. Simply selecting a variety based on its yield potential over another variety could result in disaster.

Black shank is the number one disease to consider when choosing a variety. If black shank exists in the field tobacco is to be planted in, select a variety with at least medium resistance. Varietal resistance along with labeled fungicides and crop rotation will help minimize yield losses to black shank. In the past when selecting for higher black shank resistance to both race 0 and race 1, varieties sacrificed yield potential. Much of the yield loss due to the lower yield potential of resistant varieties compared to nonresistant varieties has been eliminated with the recent release of burley varieties KT 204 LC and KT 206 LC.

KT 206 LC (tested as KTH 2404) was released jointly by the University of Kentucky and the University of Tennessee and offers some improvements. KT 206 LC has a good disease package and the best black shank resistance currently available. It has a 10 level to race 0, indicating no black shank symptoms would be expected in fields with only race 0 black shank, and a 7 level to race 1. With many burley-growing areas now reporting the presence of race 1 black shank in combination with race 0, KT 206 LC is expected to provide good black shank tolerance. In areas with heavy race 1

black shank pressure, products containing mefenoxam (Ridomil Gold or Ultra Flourish) are still recommended for KT 206 LC.

KT 206 LC has also shown some tolerance to blue mold. Tolerance to blue mold is not as good as NC 2002, so KT 206 LC will not be symptom free. It should be comparable to TN 90 LC in terms blue-mold tolerance.

N 7371 LC was released by Newton Seeds Inc. in 2007. Early indications are that its resistance to black shank early in the season may be fair, but preliminary tests indicate that the resistance does not hold up later in the season. However, results may vary depending on the predominant black shank race and the weather during the growing season. N 7371 LC is a late maturing variety with a high number of long but narrow leaves and is a high-yielding, good-quality variety. Topping may be slower than comparable varieties due to the smaller upright leaves in the top of the plant at topping time.

Hybrid 404 LC is expected to be released by Clays Seed Inc. for the 2008 season. This variety must meet final approval before it can be officially released. It is described as high yielding, semi-upright, and medium green in color. In limited testing during the 2007 growing season, it appeared to hold up very well under drought conditions. It is reported to have black root rot resistance, which would make it a better choice than Hybrid 403 LC for second-year tobacco. It does not have black shank resistance and should not be used in fields with a history of black shank. Yield potential is expected to be similar to Hybrid 403 LC.

HB 3307P LC is expected to be released by F.W. Rickard Seed Company for the 2008 growing season. This variety must meet final approval before it can be officially released. HB 3307 PLC is described as a medium maturity variety with good yield potential and quality. It is expected to have high resistance to race 0 black shank and moderate resistance to race 1. It should have moderately high yield.

KT 204 (tested as KTH 2006) was released jointly by the University of Kentucky and the University of Tennessee. It is a moderately late maturing hybrid with high yield potential. KT 204 has moderately high resistance to black shank, in comparison to other burley varieties, and is recommended for growers with serious black shank problems. It has a high level of resistance to black root rot. KT 204 is resistant to tobacco mosaic virus, wildfire, and the virus complex (potato virus Y, tobacco etch virus, and tobacco vein mottling virus). KT 204 has a higher cured-leaf quality than does KT 200, thus, it would be a better choice for controlling black shank. KT 204 is not as tolerant to blue mold as is TN 90.

NC 7 (tested as NC 2001) was developed by North Carolina State University. It is a moderately high yielding hybrid with resistance to tobacco mosaic virus, the virus complex, and wildfire. NC 7 has a high level of resistance to fusarium wilt and black root rot. NC 7 has a high level of resistance to race 0 black shank and a low level of resistance to race 1 black shank. NC 7 seems to hold up well in the piedmont area of Virginia compared to many other varieties. Seed is available from Gold Leaf and Workman Seed Companies.

NC 2002 (tested as DH 6008) was developed by North Carolina State University. It has moderate yield potential of a high-quality cured leaf. NC 2002 has good blue mold resistance, very similar to NC 2000. NC 2002 is late maturing but about five to seven days earlier than NC 2000. It is susceptible to black shank, the virus complex, and has a low level resistance to black root rot. It is resistant to tobacco mosaic virus. Seed will be available from F.W. Rickard Seed Company.

The agronomic characteristics of the burley tobacco varieties tested at the Southwest Virginia Agricultural Research and Extension Center in 2007 are shown in Table 1. Disease resistance of the burley varieties is discussed in the disease section of the production guide on page 43. For more detailed information on varieties, contact you local Extension agent.

Table 1. Yield and agronomic data for released varieties tested at the Southwest Virginia Agricultural Research and Extension Center, Glade Spring, 2007.

		Plant			Top Leaf	
	Yield	height	Leaf	Days	L	W
Cultivar or Line	lbs/A	inches	no.	to flower	--inches--	
KY 14 x L8 LC	3413	48.5	18.6	62	23.0	10.9
HB 3307 LC	3180	48.3	20.4	71	20.2	9.1
TN 90 LC	2981	50.1	19.6	68	20.6	9.4
TN 97 LC	3249	49.9	21.7	69	22.3	9.7
KT 204 LC	3189	50.1	20.8	69	20.1	9.5
KT 206 LC	3275	49.6	23.3	75	21.5	8.9
NC 3	3253	48.4	19.4	70	21.0	9.5
NC 5	3253	47.0	20.1	69	21.2	9.3
NC 6	3205	47.9	17.5	72	20.1	9.4
NC 7	3240	48.2	20.6	77	20.1	9.8
NC 2000	3129	49.9	22.0	77	18.4	8.4
NC 2002	3051	49.1	21.4	69	20.9	9.5
NC BH 129	2925	44.8	18.8	65	22.8	9.6
R 630 LC	2968	50.5	19.9	66	22.5	11.1
R 712 LC	3123	51.3	20.1	67	21.3	10.1
HB04P LC	3162	45.0	18.7	65	24.7	11.7
N 7371 LC	3110	53.9	23.2	77	19.9	8.5
Clay's 403 LC	3331	45.8	18.7	66	23.3	10.1

TRANSPLANTING AND SPACING

The time of transplanting depends largely 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 better than a later planting because the moisture conditions for quick, early growth are usually better. Good stocky plants with a healthy root system are essential to obtaining a full stand without replanting. Plants 6 to 8 inches in length with stems about the diameter of a pencil live better and grow more rapidly than smaller or larger plants.

Using a properly adjusted mechanical setter is highly desirable and results in a stand with better early growth than a hand-set stand. Replanting missing plants is usually not an economical practice if the original stand is 90 percent or more. With a limit on the pounds of burley that 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 either were 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 percent or better stand without replanting by setting only strong, stocky plants about 6 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 Width (Inches)	Spacing in Rows (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.

Treatments[1]	Plant spacing	Percent by weight		
		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-inch spacing produced a higher acre yield than the 24-inch spacing at each fertility level, with an average 4.15 percent increase for the closer spacing. The 18-inch 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-inch spacing returned $37.90 per 100 plants, while plants at the 24-inch spacing returned $48.63 per 100 plants or 28.31 percent more per plant.

There was a slight trend for tobacco from the 24-inch 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-inch 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 you must give special attention to this phase of production to realize the highest net profit.

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 (6.0 - 6.5) 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, consider the following factors when 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.

Because many factors must be considered 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	150-250	250-350
M	175-200	60-100	200-250
H	175-200	40	100-200
VH	175-200	40	50-100

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 is 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 pounds 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.

Yield of Burley Tobacco by Nitrogen Rate – Average of 12 Experiments
2004-2006 Tennessee, Virginia, and Kentucky

Sidedress Nitrogen (lbs N/acre)	Preplant Nitrogen (lbs N/acre)		
	80	160	240
	---------- Yield (lbs/acre)----------		
0	2358	2520	2643
50	2527	2660	2659
100	**2648***	**2647**	**2652**

*Yields in **bold type** are not different from each other by statistical tests.

These results, across a wide variety of soils and growing conditions, show that burley yields top out at no more than 180 pounds per acre of nitrogen when split into a preplant and sidedress application, and at no more than 240 pounds per acre without sidedressing. Applying 160 pounds per acre without sidedressing actually maximized yield in nine out of 12 trials, but in three cases in wet seasons, the tobacco did respond to an extra 50 pounds sidedressed. Across all 12 experiments, including some wet years, there was never a yield response to sidedressing when 240 pounds of nitrogen were applied preplant. These results are consistent with university recommendations, especially when the N is partly applied as a sidedress. In this case, farmers can consistently reach top yields with less than 200 pounds nitrogen per acre.

Phosphorus is probably the most excessively used nutrient in tobacco fertilization in Virginia. Repeated applications of larger quantities of phosphorus than plants can absorb with essentially no loss from leaching have resulted in a general buildup of this element. Fertilizer sales indicate that generally about twice as much phosphorus is used on tobacco as is needed. Based on a summary of soil analyses of tobacco fields by the Virginia Tech Soil Testing Laboratory, approximately 88 percent 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 than any other element. Potassium is necessary not only for growth, but it also enhances the burning quality of 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 will 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 pounds 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”), you should use nonchlorine sources of potash, i.e. potassium sulfate (0-0-50) or potassium nitrate (13-0-44). Do not use muriate of potash (0-0-60). Do not apply than 30 pounds of chlorine per acre to burley tobacco.

Selecting the Fertilizer Grade

Once the N, P_2O_5, and K_2O requirements have been determined, you 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
11-6-20	1000	110	60	200
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 precisely. By shopping for the best price, you can obtain a less costly fertilizer program.

Transplant Starter Solutions

Using 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 evaluated five of the many products available. The study evaluated starter fertilizers using both plant bed- and greenhouse-grown transplants. Treatments tested included the following.

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 Treatments 3 through 6 (high P) resulted in more rapid early-season growth than observed with the low P fertilizer (Treatment 2) or untreated plants (Treatment 1). As plants neared topping stage, differences between the treatments tended to diminish. However, plants in Treatments 3 through 6 did come into top earlier than those in Treatments 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. There was no significant difference in the yield of any of the treatments for both plant bed and greenhouse transplants, regardless of the observed early-season growth effects (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	Percent of plants topped by July 19		Yield (lbs/a)	
Fertilizer	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 percent 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 the 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. The 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	Soil Type		
Unlimed Soils	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 should be applied as indicated by a soil sample. 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 such as boron.

Manganese Toxicity

Acid soils increase 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

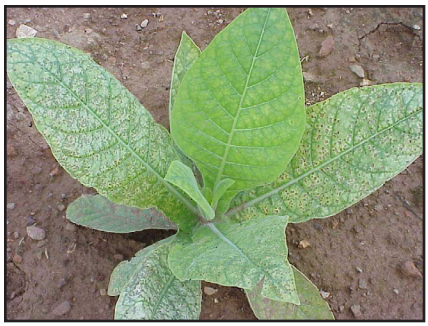

Figure 1. Manganese toxicity in burley tobacco

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 that 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 is usually 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 at this time to indicate that the application of micronutrients should become a general practice in the fertilization of burley tobacco.

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 up the crop.

TOPPING AND SUCKER CONTROL

Topping

Research has shown that burley tobacco benefits from early topping before the development of the full flower stage. Generally, you should try to top tobacco at the elongated-bud to early-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 use them successfully.

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. It requires a sufficiently concentrated solution of contact material to obtain adequate sucker control. Use a 4-percent solution or 2 gallons in 48 gallons 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. MH should be applied in a total spray volume of 50 gallons per acre.

3. The *local systemic* (Prime+ and 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 control at a 4-percent concentration (2 gallons in 48 gallons of water or 5 ounces in 1 gallon 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+ or Butralin at 2 quarts per acre with 1 to 2 gallons per acre of MH or 4 fluid ounces of Prime+ or Butralin and 16 fluid ounces of MH in 3 gallons of water.
   - FST-7 alone at 3 gallons per acre or tank mixed with Prime+ or Butralin (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 quarts per acre with 1 to 2 gallons per acre of MH.
- FST-7 alone at 3 gallons per acre or tank mixed with Prime+ (FST-7 is a commercial product combining MH with contact fatty alcohol).

Program III. Prime+/Butralin 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. **You must 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 a 4-percent concentration in order to kill both primary and secondary suckers. It may be necessary to increase the concentration to 5 percent 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 have 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 a boom type sprayer, knapsack, or jug application. Butralin should be mixed at 1.7 fluid ounces per gallon of water. One gallon of the mixture should treat approximately 200 plants. Larger quantities may be mixed with 2 quarts of butralin in 35 gallons 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 to 2.0 gallons 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.

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 means workers must wear all required personal protective equipment to comply with WPS. Growers are also responsible for the 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)	3-4% 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+ or Butralin	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

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Starting the growing season with an adequate supply of quality transplants is the first step to producing a high-yielding and high-quality crop. Greenhouse transplant production has become the primary method of transplant production. There are several advantages to producing transplants in the greenhouse in comparison to traditional 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 can be a significant problem in some 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 (Figure 2). 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 usually it will not result in a useable transplant.

Figure 2. Example of spiral-root seedling and normal seedling

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 filling and not over packing the 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 suggests a combination of factors is responsible for spiral-root seedlings. These factors include seed pellet, variety, soilless media, and environment. Research has shown that the seed pellet is an integral factor in the cause of spiral rooting. Tests have shown differences in 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. Tests have also shown differences between seed companies' pelleting processes. Other factors such as growing media and environmental conditions seem to be important in how they interact with the seed pellet to allow the pellet to dissolve or breakdown. 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.

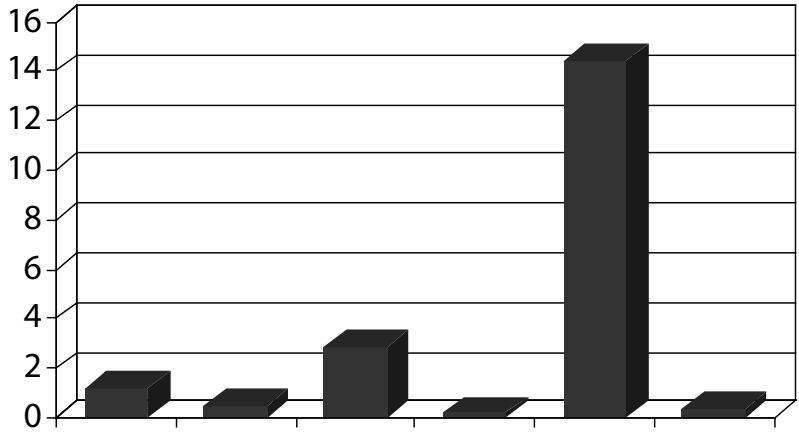
Consistent differences have shown up among burley varieties and the incidence of spiral rooting. For example KY14xL8 has proven to result in more spiral-root seedlings than most other varieties. As described above, many of the causes of spiral-root seedlings may be largely out of the hands of the growers. Growers cannot alter the properties of the seed and/or pellet. Growers should not try to alter the properties of a growing medium but rather avoid using a medium 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, and not the thermostat controls, should be used as an indicator of temperature. The optimum temperature is 70°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 and the most uniform stand of plants.

Seed Covering to Reduce Spiral Roots. Research has evaluated the practice of covering seeds to reduce or eliminate spiral-root seedlings. The purpose of covering the seed is to provide a more consistent environment around the seed pellet. Research conducted at Virginia Tech and North Carolina State University has shown that covering with growing medium and vermiculite is very effective in reducing the incidence of spiral rooting. However, even distribution of small amounts of these materials is difficult.

Uneven or excessive covering of the seed can result in decreased uniformity of seedling emergence and may result in a reduced plant stand. Ag-Gromate, 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. However, growers who 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 one to three days, growers should delay fertilization one to three days after seeding to reduce the chance of salts injury. Additionally, growers should contact their local Extension agent for information on covering seed.

Figure 3: Effects of covering seeds from burley variety TN 90 with different materials and methods on the incidence of spiral-root seedlings



GREENHOUSE MANAGEMENT PRACTICES

Greenhouse production of tobacco transplants involves a much greater level of supervision and management than is 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

It is difficult to precisely control the temperatures in greenhouses used for tobacco transplant production. It's more difficult to keep temperatures cool than it is to keep it warm enough, especially on sunny days. The most demanding period for heating is during the germination of the seed. The ideal temperature for seed germination is 70°F. However, preliminary research shows you can reduce the temperature to 60°F at night and allow the temperature to increase to 80°F during the day and still reach 95 percent germination in 12 days. Extended periods of cooler temperatures will delay germination. After germination, the minimum temperature may be reduced to 55°F. Preventing high temperatures is equally as important as providing necessary heat for a greenhouse. Young seedlings are particularly sensitive to high temperatures, thus the temperature should be kept below 95°F during the two- to four-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 105°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 specially processed seed that is "pregerminated" under controlled conditions and then pelleted. The use of primed seed will reduce the heating requirement and is recommended, especially in outdoor float beds. The germination rate of primed seed at 60°F will be similar to unprimed seed at 70°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 completely filled for their entire depth to wick properly and prevent dry cells; but avoid over packing the cells 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, avoid excessively moist media since better plant stands are generally obtained with a medium having a dry consistency rather than a medium with more moisture and, therefore, a heavier consistency. Media should have only enough moisture to keep 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 you water trays, use only a fine mist should be used to prevent packing and water logging 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. In addition to using the correct fertilizer material, proper fertilization requires an accurate concentration of fertilizer solution 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 the bay, the fertilizer analysis, and the desired nutrient level of the float bay. Additional information on fertilization is presented on pages 27 and 29.

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 the 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. Growers should be able to produce good, uniform transplants by clipping three to five times. A higher number of clippings indicates the greenhouse was seeded too early. Seeding earlier than necessary will increase heating costs and the potential for disease problems.

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 three-day interval between the first three clipping dates and every five 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-percent chlorine bleach solution following each use.*

The description of greenhouse tobacco transplant production is greatly abbreviated. Additional information is available from your local Extension agent and is detailed in the *Float Greenhouse Tobacco Transplant Production Guide,* Virginia Cooperative Extension publication 436-051.

Float Fertilization Programs

Fertilization program suggested for float greenhouse tobacco production, depending on management level.

	Program	
Fertilizer Addition	**I**	**II**
	--- ppm N ---	
at seeding	0	75
3-5 days after seeding	75	
4 weeks after seeding or at 1st clipping	100	100

Under normal circumstances no additional fertilizer should be necessary beyond the total of 175 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 (50 to 75 ppm N) may be necessary to maintain adequate seedling nutrient levels.

Program I is the preferred fertilization schedule. This program delays fertilization until the trays have wicked. This helps to minimize fertilizer salts injury to young seedlings, increasing the total number of useable transplants. Research conducted at the Southern Piedmont AREC showed that delaying the addition of fertilizer by even one day resulted in lower conductivity of the media in the upper part of the cell as much as 21 days after seeding. Recently germinated seedlings need low levels of nutrients and most commercially available tobacco mixes will provide these nutrients. Nitrogen at 75 ppm is adequate for burley transplants for the first four weeks. Not allowing the fertilizer levels to become excessive will help reduce disease levels and the number of clippings necessary to produce a quality transplant.

Program II provides seedlings with 75 ppm N fertilizer level at seeding, making it easier to uniformly distribute the fertilizer across a bay. This program would primarily be used in outdoor float beds. Outdoor float beds result in less water evaporation 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.

Comparison 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 one or two 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 has 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 cannot be satisfactory substituted with common potting media used with houseplants. Greenhouse tobacco mixes should be available from most farm supply dealers. When filling trays, media should have sufficient moisture to prevent it from falling out of the cells. Fresh media should not need any additional moisture. Tobacco mixes should not be carried over from one year to the next. The wetting agent degrades and thus, the cells don't wick.

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 again 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 water logging of the media.

Tray selection will influence both the productivity and management of a greenhouse. Most trays used today are made of polystyrene and manufactures control the density of the tray by the amount of material put into the mold. Higher density trays seem to be more durable and have a longer useable life than low-density trays. However, higher density trays are also more expensive. Lower density trays may be useful for produces selling transplants and plan to purchase new trays annually to reduce disease pressure.

A relatively new tray on the market is the "glazed tray" made in a process where the manufacturer seals the inner surface of the cells. The tray is reduced in height by approximately 0.5 inch; however, the same amount of polystyrene is used so the tray is of higher density. This tray should be durable enough to be reused for several seasons, but it is more expensive.

An additional tray for 2008 season is a "shallow tray." This tray is the same length and width as a regular tray. However, the tray is only 1.5 inches deep compared to 2.5 inches deep for the normal tray. The only real advantage to the shallow tray is the need for less soilless media. Limited research shows little difference in seed germination and seedling growth. More research is needed to confirm that the number of useable transplants is not reduced by the minimal savings in soilless media cost.

Most of the 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; 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 evaluated 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 392s, 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 the transplant number needed against the ability to adequately heat the float beds.

Attention to seeding the trays will result in a greater number of usable transplants. Tray cells not seeded or double seeded will reduce the number of transplants. Proper tray dibbling (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 the 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 AREC in 1993 and 1994 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 inches wide and 26.5 inches 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 inches of additional space

along the length and width of the bed to allow easy 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-size 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 as follows:

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).

	Number of transplants from 40 trays with	
Float tray cell number	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 an 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 one 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-inch side) around the water bed to attach cover support bows made from 0.75-inch 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 feet.

Bows supporting the cover can be made from 0.5- or 0.75-inch plastic PVC pipe. Space bows 18 to 24 inches apart. The length of the bows should be 90 inches for a float bed 4 trays wide and approximately 104 inches 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 square feet) 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 heat loss occurring at night by radiation. 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 are large enough to 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 (2.5 mil) grade of this cover be used for float beds, and that the cover be turned with the rough side up to better shed water.

Resent research has shown the use of a 50 percent white shade plastic to be a very effective cover for outdoor float beds. Growers should be sure that the shade plastic is actually 50 percent. 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 percent shade plastic with the outdoor float bed than in a traditional greenhouse. This is thought to be a result of higher humidity in the float bed and less drying of the seed and pellet.

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 Diagnosis of Disease Problems is the first step in controlling burley tobacco diseases. Note any signs of disease during the growing season. Take plant and soil samples and have them analyzed to identify the cause of the problem. Do not 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. The length of rotation (the longer the better) and the types of alternate crops are among the most important rotation considerations. Table 1 lists some possible rotation crops.

Table 1. Usefulness of Various Rotation Crops for Tobacco Disease Control[1]

Rotation Crop	Black Shank	Granville Wilt	Root-Knot Nematodes	Tobacco Cyst Nematodes	Tobacco Mosaic Virus	Black Root Rot
Fescue	H	H	H	H	H	H
Small grain	H	H	H	H	H	H
Lespedeza 'Rowan'	H	H	H	-	H	L
Soybean	H	H	L[3]	H	H	L
Corn	H	M	L	H	H	H
Sweet potato	H	M	L[4]	-	H	H
Cotton	H	M	N	-	H	L
Milo	H	M	L	H	H	H
Peanuts	H	L	N	H	H	L
Pepper	H	N	N[2]	L	N	H
Potato, Irish	H	N	L	L	H	H
Tomato	H	N	N[3]	N	N	M

[1]Adapted from Table 9-2, Flue-Cured Tobacco Information 2006, North Carolina Cooperative Extension Service. Ratings indicate the value of each rotation crop for reducing damage caused by each disease in the subsequent tobacco crop and assume excellent weed control in each rotation crop; H = highly valuable, M = moderately valuable, L = Little value, N = no value – may be worse than continuous tobacco, - = unknown.

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

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

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

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. 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 two 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, but significant losses can still occur under heavy disease pressure. Crop rotation and early root destruction should be used along with resistance. Fungicide use is often necessary when susceptible varieties are planted frequently in fields with a history of 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.

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 grower's 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.

Float trays should be cleaned and then fumigated with methyl bromide or aerated steam (140°F to 175°F for 30 minutes) to minimize Rhizoctonia damping-off and sore shin. Dry trays should be loosely stacked no more than 5 feet high and completely enclosed in plastic. One pound of methyl bromide will fumigate 300 cubic feet (400 trays). Trays should be fumigated 24 to 48 hours, then aerated for at least 48 hours before use. Be sure to read the label for space fumigation and follow it exactly.

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

Start a weekly application of 0.5 pound of Dithane DF per 100 gallons of water (1 level teaspoon per gallon) approximately one week after seedlings are big enough to cover the tray cells. Increase the spray volume from 3 to 6 gallons per 1,000 square feet as plants grow. Continue fungicide applications until seedlings are transplanted.

Minimize overhead watering and potential splashing of the media from one tray cell to another. Correcting drainage problems in and around the greenhouse will also help avoid excess humidity. Running horizontal airflow fans and lowering side curtains near sunset will help equalize air temperatures between the inside and outside your greenhouse and reduce condensation in the greenhouse, making conditions less favorable for disease.

Sanitize mower blades and decks 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. Use high vacuum mowers to clip tobacco seedlings. Dump clippings, unused plants, and used media at least 100 yards from the greenhouse.

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

SPECIFIC DISEASES IMPORTANT IN VIRGINIA

Black Root Rot causes 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 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 three-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 is caused by a fungus-like pathogen that lives in soil and attacks tobacco roots and stalks. Disease losses usually can be avoided by planting highly resistant cultivars in fields that have been rotated in and out of tobacco production. The longer the interval between tobacco crops, the less black shank to be expected. **Burley tobacco cultivars possessing the L8 and *Ph* genes are highly resistant to race 0 of the black shank pathogen, but susceptible or much less resistant to race 1.**

The following table presents recent Virginia on-farm test results comparing survival of burley tobacco varieties in black shank-infested fields with high disease pressure (without a soil fungicide).

	Race 1		Race 0		
	KY-TN Rating	% Survival	KY-TN Rating	% Survival	
Variety	(0-10)	2007	(0-10)	2005	2007
KT 206	7	29.3	10	not tested	99.7
KT 204	7	25.6	7	24.7	98.1
KT 200	6	30.3	6	20.1	*not tested*
TN 90	4	3.6	4	16.9	82
NC 5	4	2.2	10	74.5	*not tested*
NC 7	7	1.0	10	53.0	*not tested*
KY14xL8	0	0.4	10	55.4	*not tested*
NC 2000	0	not tested	0	6.4	*not tested*
NCBH 129	1	0.1	1	0.1	34.2

Using a soil fungicide cannot guarantee adequate black shank control in fields planted with tobacco every year (no crop rotation). Soil fumigation is not as effective against black shank as it is when used to manage Granville wilt or nematodes.

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.* The 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 is tobacco. NC 5, NC 6, NC 7, and Clay's Hybrid 402 are resistant to common root-knot nematodes (M. incognita races 1 and 3). Burley tobacco is generally resistant to tobacco cyst nematodes.

Blue Mold can be reduced by obtaining transplants locally rather than production areas outside Virginia. Apply blue mold fungicides as soon as the Blue Mold Forecast System (on the Internet at *www.ces.ncsu.edu/depts/pp/bluemold/*) predicts a moderate to high risk of blue mold in your area. Dithane, Forum tank-mixed with Dithane, and Aliette should be applied to maximize coverage of all leaves.

The following table illustrates the spray volumes required.

	Gallons of Spray Mixture/Acre	
Crop Stage	**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

Use hollow-cone type nozzles to ensure thorough coverage of all leaves. You can use air blast sprayers for small plantings. Mix fungicides at twice the normal concentration when using an air blast sprayer. However, cut the spray volumes in half when using an air blast sprayer.

Complete coverage is not required when using Actigard for blue mold control. However, tobacco plants need four to five days after an application of Actigard before they are fully protected from disease. Initial use of Actigard should occur within three days of any previous fungicide application. If this is not possible, tank mixing 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. Follow the Actigard label very closely to minimize potential yellowing or stunting of the crop.

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

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 (FS) – Greenhouse applications should not begin until seedlings are at least the size of a dime, but should be repeated at five- to seven-day intervals up to transplanting. Use flat-fan, extended-range tips at approximately 40 psi to maximize results. Field sprays should generally be performed using hollow-cone tips to apply a fine spray of 20 to 100 gallons per acre to maximize coverage as plants increase in size. Spray pressures should generally range between 40 and 100 psi. Using drop nozzles will significantly improve disease control after layby by improving spray coverage on bottom leaves, where foliar diseases are usually concentrated.

Fumigation: F-Row – Inject the fumigant 6 to 8 inches deep with one chisel-type applicator in the center of the row. Seal the soil 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. Seal the soil 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]

Variety	Black Shank Rating for Race 0 Verbal	Black Shank Rating for Race 0 KY/TN [2]	Black Shank Rating for Race 1 Verbal	Black Shank Rating for Race 1 KY/TN [2]	Black Root Rot	Fusarium Wilt	Tobacco Mosaic Virus	Wildfire	Brown Spot	Blue Mold	Aphid Transmitted Viruses
KT 206	H	10	MH	7	H	--	H	H	--	4	H/M[4]
NC 7 [3]	H	10	L-M	3-4	H	H	H	H	--	0	H/M[4]
KY 910	H	10	M	4	H	L	H	H	--	0	H/M[4]
NC 5 [3]	H	10	M	4	H	S	H	H	--	0	M
NC 6 [3]	H	10	L	2	H	S	H	H	--	0	M
KY 14xL8	H	10	S	0	M	M	H	H	T	0	S
KT 204 LC	MH	7	MH	7	H	L	H	H	--	0	H/M[4]
KT 200 LC	M	6	M	6	H	S	H	H	--	0	H/M[4]
TN 97 LC	M	5	M	5	H	S	H	--	--	0	H/M[4]
VA 509	M	5	M	5	L	L	S	H	VS	0	S
TN 86 LC	M	4	M	4	H	S	S	H	--	0	H/M[4]
TN 90 LC	M	4	M	4	H	S	H	H	--	2	M
R-630	M	3	M	3	M	L	H	H	--	0	H/M[4]
KY 907 LC	L	2	L	2	H	M	H	H	--	0	H/M[4]
NBH 98	L	2	L	2	M	L5	H	H	--	0	S
NC BH-129	S	1	S	1	H	S	H	H	--	0	S
Clay's 403	S	0	S	0	M	M	H	H	--	0	S
HB 04P	S	0	S	0	H	--	H	H	--	0	S
NC 2000	S	0	S	0	L	VS	H	H	S	7	M
NC 2002	S	0	S	0	L	VS	H	H	S	7	S
R-711	S	0	S	0	M	L	H	H	--	0	S
R-712	S	0	S	0	H	S	H	H	--	0	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]Highly resistant to Tobacco Vein Mottling Virus (TVMV) but moderately resistant to Tobacco Etch Virus; TVMV is the most commonly occurring of the aphid-transmitted viruses on burley tobacco.

DISEASES OF TOBACCO SEEDLINGS

Disease	Material	Rate	Remarks
Angular Leaf Spot or Wildfire (Pseudomonas)	Agrimycin 17, Bac-master, Firewall, Farmsaver, Streptomyin, Streptrol, etc.	100-200 ppm (2-4 tsp/3gal)	100 ppm = 4 oz/50 gal or 0.5 lb/100 gal for preventative sprays. 200 ppm = 0.5 lb/50 gal or 1 lb/100 gal after disease occurs.
Anthracnose (Colletotrichum gloeosporoides) Blue Mold (Peronospora tabacina) Target Spot (Thanatephorus cucumeris)	Dithane DF	0.5 lb/100 gal (1 level tsp/gal)	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 to 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.
Blue mold (Peronospora tabacina)	Aliette WDG	0.5 lb/50 gal water	For preventative control of blue mold. **Can cause leaf burn if washed into greenhouse media or float water.** Only 2 applications allowed. Do not exceed 0.6 lb product/1,000 sq. ft. per application.
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.
	Terramaster 4EC	Preventative: 1 fl oz/100 gal Sequential: 0.9 fl oz/100 gal Curative: 1.4 fl oz/100 gal 2nd Curative: 1-1.4 fl oz/100 gal	Can be used before or after symptoms appear, but no earlier than 2 weeks after seeding. If symptoms reappear, a second application can be made no later than 8 weeks after seeding. No more than 2.8 fl. oz./100 gallons of water may be applied to any crop of transplants, regardless of the number of applications. **MUST BE EVENLY DISTRIBUTED.** When mixing, first form dilute emulsion, then distribute emulsion 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 Ultra Flourish	1-2 pt 1-2 qt	Preplant Preplant	F F	—	—
Ridomil Gold EC Ultra Flourish	1.0 pt + 1.0 pt 2 qt + 2 qt	Preplant + layby Preplant + layby	G G	—	—
Ridomil Gold EC Ultra Flourish	1.0 pt + 1.0 pt 2 qt + 2 qt	1st cultivation + layby	G G	—	—
Ridomil Gold EC Ultra Flourish	1 pt + 0.5 - 1.0 pt + 0.5 - 1.0 pt 1 qt + 1-2 qt + 1-2 qt	Preplant + 1st cultivation + layby	VG VG	—	—
Telone C 17 Chlor-O-Pic Chloropicrin 100 Pic Plus	10.5 gal 3 gal 3 gal 4 gal	F-Row F-Row F-Row F-Row	P-F P-F P-F P-F	F F F F	G G G 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, 3 pt. of Ridomil Gold EC, or 3 lb. of Ridomil Gold WSP 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 Fungicides Acibenzolar-S-methyl	Actigard 50WP	0.5 oz/20 gal/A	Foliar	Begin application when blue mold threatens and plants are 18 inches tall. Up to 3 sprays are allowed, no more than 10 days apart. Treated plants require 4 to 5 days to fully respond to each application.
Mefenoxam	Ridomil Gold EC	0.5-1 pt + 0.5 pt/A	Preplant + Layby	Strains of the blue mold pathogen are often 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 Fungicides Dimethomorph and Mancozeb	Acrobat MZ	2.5 lb/100 gal of water	Foliar Spray	Begin sprays when the Blue Mold Advisory predicts conditions favorable for disease. Continue applications on a 5- to 7-day interval until the threat of disease subsides. Apply 20 to 30 gal/A of spray solution during the first several weeks after transplanting and gradually increase spray volume as the crop grows. Spray volumes should reach 40 gal/A by layby and should range between 80 and 100 gal/A on tobacco ready to be topped. Do not exceed 2.5 lb/A of Acrobat per application (10 lb/A per season). Do not apply after the early button stage or within 21 days of the first harvest.
	Acrobat 50WP + Dithane DF Rainshield	7.0 oz/100 gal water + 2.0 lb/100 gal water		
	Forum + Dithane DF Rainshield	7.0 fl oz/100 gal water + 2.0 lb/100 gal water		
Fosetyl-aluminum	Aliette WDG	2.5-4.0 lb/A	Foliar Spray	Do not apply Aliette within 3 days of harvest or 4 lb/A of Aliette per application (20 lb/A per season). Do no tank mix Aliette with copper compounds, foliar fertilizers, surfactants, or adjuvants that increase pesticide penetration.

FIELD DISEASES OF TOBACCO (Cont'd)

Foliar Diseases - Target Spot, Frogeye, and Blue Mold

Chemical	Material	Rate[1]	Application Method[2]	Comment
Blue mold (Peronospora tabacina); **Frogeye** (Cercospora nicotianae); **Target Spot (** Thanatephorus cucumeris)	Quadris	6-12 fl. oz.	Foliar Spray	**Remarks:** First application for blue mold should be made at first indication of disease in the area; for target spot, spray at or soon after layby; don't spray Quadris "back-to-back" for blue mold, but alternate with another fungicide; spray sufficient water volume for complete coverage and canopy penetration; may enhance weather flecking, but this shouldn't affect yield or quality; up to 4 applications/year allowed; may be applied up to the day of harvest; tank mixing with insecticides formulated as ECs or containing high amounts of solvents may cause some crop injur

[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 the 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.
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.

WEED CONTROL IN BURLEY TOBACCO

Charles S. Johnson, Extension Plant Pathologist, Tobacco

Good weed control uses crop rotation, early root destruction, cultivation, and the appropriate use of herbicides. Using an herbicide will reduce dependence on the first cultivation for early-season weed control. 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 depend upon the use of correct application methods. Make a special effort to apply all herbicides exactly as stated on the product label.

IMPORTANT CONSIDERATIONS IN HERBICIDE USE

Selecting the Proper Herbicide

Weed Identification - Identifying the problem weeds in each field should be the first step in any weed control program. Check herbicides to ensure that the products are active against the desired weeds. The 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 52 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 the percent organic matter increases and as the soil texture changes from coarse to fine. However, the lowest recommended rate should always be used when the percent organic matter is less than 1 percent, 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. You can determine the percent organic matter of your soils 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. Thoroughly work all weed growth and crop stubble into the soil prior to application of most tobacco herbicides. The soil should be moist and loose, with all clods broken up, before an herbicide is applied.

Spray Equipment - Use a standard low-pressure (25 to 50 psi) boom sprayer 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 an herbicide in strong wind, since wind can cause uneven coverage. Poast must be applied at higher pressures (40 to 60 psi) using smaller spray volumes (5 to 20 gallons of water per acre). Use only hollow-cone or flat-fan nozzles to apply Poast. Never leave a spray mixture in a sprayer overnight!

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

Undesired Effects of Herbicide Use

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

Effects of Herbicides on Rotation Crops - Residues from some tobacco herbicides may reduce the growth of crops following tobacco. These effects are discussed in the labels for the particular herbicides involved. Potential carry-over can be reduced by: 1) using the minimum labeled rates for the chemical for your weed problems on your soils; 2) applying herbicides in a band at transplant-

ing and/or layby rather than broadcast PPI; 3) fall tillage for early root and stalk destruction; and, 4) by deep plowing before seeding the winter cover crop.

Preplant Incorporated Herbicides (PPI)

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

Over-the-top after Transplanting and Layby Herbicides

An OT application can be made as either a band or broadcast application within seven days of transplanting. Tillage is required immediately before or at the time of an OT application if the application is made more than two 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.

Apply layby herbicides as directed sprays to row middles immediately after the last normal cultivation. Use drops equipped with flat, flood-jet (TK2, TK4, etc.) or even, flat-fan (8004, etc.) nozzles to apply the herbicide solution in a 16- to 30-inch band in the row middles. Use nozzles that apply one-half (1/2) the normal number of gallons per acre where spray nozzles on the end of the boom pass over the same row middle twice (to prevent over-application). Use the formula above to determine the amount of product to use for a band application. Irrigation will be required if 1 to 2 inches of rain do not fall within seven to ten 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	Bermuda-grass	Broadleaf Signalgrass	Crab-grass	Crowfoot grass	Fall Panicum	Fox-tails	Goose-grass	Johnsongrass (seedling)	Texas Panicum	Nut-sedge
Command	E	P-F	E	E	E	E	E	E	G	G	P
Devrinol	G	P	F	E	E	G	E	E	F	--	N
Poast	F-G	G	E	G	F	E	E	G	E	E	N
Prowl or Pendimax	G	P	G	E	E	G	E	E	G	G	N
Spartan	F	P	P	F	F	F	F	F	F	F	E
Tillam	G	P	P	E	E	G	E	G	G	P	G

Broadleaf Weeds

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

WEED CONTROL IN BURLEY TOBACCO FIELDS

Weed Problems	Soil[1] Texture	Chemical Lbs Active Ingredient/A	Product per Acre	Application[2] Method	Remarks
Pigweed, lambsquarters, nightshade, purslane, smartweed, velvetleaf, spurred anoda, carpetweed, cocklebur, cotton, groundcherry, morningglory, common ragweed		carfentrazone 0.012-0.024 0.013-0.023	Aim 0.5-1.0 oz. Aim EC or Aim EW 0.8-1.5 fl. oz	Pretransplant burndown; shielded or hooded spray before layby	Aim is a contact "burndown" herbicide for controlling emerged and actively growing broadleaf weeds. Can be tank mixed with other herbicides, but should be added first, **WILL BURN TOBACCO LEAVES ON CONTACT.**
Barnyardgrass, broadleaf signalgrass, crabgrass, field sandbur (suppression), foxtails, seedling Johnsongrass, fall panicum, velvetleaf, jimsonweed, lambsquarter, prickly sida, purslane, spurred anoda, venice mallow, common ragweed, smartweed, cocklebur (suppression), shattercane	 Coarse Fine	clomazone 0.75 1.0	Command ME 2.0 pt 2.7 pt	OT	Use the higher rate for heavy weed pressure or heavy soils. Do not use in plant beds.
Barnyardgrass, carpetweed, crabgrass, fall panicum, foxtails, goosegrass, johnsongrass from seed, lambsquarter, pigweed, common purslane, ragweed (suppression), ryegrass, check label for uncommon weeds.	 Coarse Medium Fine Coarse Medium Fine	napropamide 1.0 1.0-1.5 2.0 1.0 1.0-1.5 2.0	Devrinol DF 2.0 lb 2.0-3.0 lb 4.0 lb Devrinol 2E 2 qt 2-3 qt 4 qt	PPI, OT, Layby PPI only	For PPI application, incorporate the same day as applied. Small-grain injury may occur with PPI application method.

WEED CONTROL IN BURLEY TOBACCO FIELDS (continued)

Weed Problems	Soil[1] Texture	Chemical Lbs Active Ingredient/A	Product per Acre	Application[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 or within 42 days of harvest.
	Single use:	0.28	1.5 pt + 2.0 pt oil concentrate		
	Sequential use:	0.19	1.0 pt + 2.0 pt oil concentrate		
Annual spurge, barnyardgrass, carpetweed, crabgrass, crowfoot grass, Florida pusley, foxtails, goosegrass, johnsongrass from seed, lambsquarters, panicums, pigweed, purslane, signalgrass		pendimethalin	Prowl 3.3 EC or Pendimax 3.3		For silt and silt loam soils, use 2.4-3.0 pt/A of Prowl 3.3EC or 2.5 pt/A of Prowl H2O for PPI applications. *Rates are for broadcast application and must be adjusted for banded sprays based on the width of the intended spray band and soil texture.* Applied according to directions and under normal growing conditions, Prowl should not harm transplanted tobacco, but can temporarily retard growth under stressful conditions (cold/wet or hot/dry weather). Layby applications should be made as a directed spray in a 16- to 24-inch band centered between rows. Spray contacting tobacco leaves may cause deformations. Crop injury may result if winter wheat and winter barley are no-till planted in the fall after spring application of Prowl. Do not feed forage or graze livestock for 75 days after planting wheat or barley in Prowl-treated land.
	Coarse	0.74-0.99	1.8 – 2.4pt	PPI only	
	Medium	0.74-1.24	1.8 - 3.0 pt		
	Fine	0.99-1.24	2.4 - 3.0 pt		
	Coarse	0.50 – 0.74	1.2 – 1.8 pt		
	Medium	0.74 – 0.99	1.8 – 2.4 pt	Layby only	
	Fine	0.74 – 0.99	1.8 – 2.4 pt		
			Prowl H20		
	Coarse	0.95	2.0 pt		
	Medium	0.95 – 1.19	2.0 – 2.5 pt	PPI only	
	Fine	1.19	2.5 pt		
	Coarse	0.71	1.5 pt		
	Medium	0.95	2.0 pt	Layby only	
	Fine	0.95	2.0 pt		

WEED CONTROL IN BURLEY TOBACCO FIELDS (continued)

Weed Problems	Soil[1] Texture	Chemical Lbs Active Ingredient/A	Product per Acre	Application[2] Method	Remarks
Cocklebur, Florida pusley, hairy galinsoga, goosegrass, ground-cherry, jimsonweed, seedling Johnsongrass, lambsquarters, morningglory, wild mustard, nightshade, nutsedge, orchard-grass, pigweed, prickly sida, Suppresses barnyardgrass, crabgrass, crowfootgrass, foxtail, panicums, signalgrass. Check label for uncommon weeds.		sulfentrazone	Spartan 75DF	After bedding, before transplanting	Apply this product only as specified on the label. Do not apply to soils classified as sands with less than 1% organic matter and shallow groundwater. *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 and within 14 days of transplanting. **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.
	Coare	0.25	5.3 oz		
	Medium	0.31	6.7 oz		
	Fine	0.38	8.0 oz		
				After bedding, before transplanting	
			Spartan 4F		
	Coarse	0.25	8 fl oz (0.50 pt)		
	Medium	0.31	10 fl oz (0.62 pt)		
	Fine	0.38	12 fl oz (0.75 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.

TOBACCO INSECT MANAGEMENT

Paul J. Semtner, Extension Entomologist

Several species of insects pose serious threats to tobacco in the field, the greenhouse, and the curing barn. Insects damage the roots, destroy the leaves and buds, reduce leaf quality, and transmit several important tobacco diseases.

INTEGRATED PEST MANAGEMENT

Integrated pest management (IPM) combines cultural, natural, and chemical controls to maintain insect pest populations below levels that cause economic damage to the crop. IPM promotes using insecticides only when they are needed. A certain amount of insect damage does not reduce crop value enough to pay for the cost of treatment. In addition, tobacco plants often compensate for insect damage. IPM helps to maximize profits; reduce pesticide residue levels, environmental contamination, and human exposure to pesticides; and it optimizes natural control provided by beneficial organisms.

Cultural controls

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

1. **Plow early in the spring** at least four weeks before transplanting to reduce cutworm infestations and aid in wireworm control.
2. **Use recommended rates of nitrogen.** Excessive rates of nitrogen fertilizer may delay maturity and make tobacco a more favorable host for hornworms and aphids after topping.
3. Adjust the **transplanting date** to reduce tobacco susceptibility to insect pests. Early-planted tobacco is often less favorable for aphids, splitworms, and hornworms and more favorable for budworms and flea beetles. Late-planted tobacco is highly susceptible to hornworm and tobacco splitworm damage and may have lower yield and quality. Aphids are usually most serious on tobacco transplanted near the middle of the transplanting period.
4. **Destroy greenhouse transplants immediately after transplanting is completed** to keep aphids and other insects from developing high populations on the transplants and migrating to the field tobacco.

5. **Manage field borders to reduce insect habitat.** Keep field margins clear of weeds and tall grass to reduce feeding, breeding, and overwintering sites for grasshoppers and other insects that move from these sites into tobacco fields. After tobacco is established and growing, leave uncut barriers between tobacco fields and hay fields that are heavily infested with grasshoppers.
6. **Top in the early flower stage** to eliminate food sources for budworms and to make the crop a less desirable host for aphids and hornworms.
7. Obtain **effective sucker control** to reduce food sources for hornworms, budworms, and aphids.
8. Destroy crop residues immediately after harvest is completed. **Stalk cutting and root destruction** reduce feeding and overwintering sites for hornworms, budworms, and flea beetles. This practice is most effective when done on a community-wide basis.
9. Plan **crop rotations to reduce infestations of soil-inhabiting insects.** Rotate tobacco with crops that are poor hosts of cutworms, white-fringed beetles, and wireworms.
10. Use conservation tillage to manage insect infestations. **Conservation tillage**, including no tillage and strip tillage, reduces aphid and flea beetle populations, but it may increase cutworm and slug infestations.

Natural Control

Beneficial organisms, including predators, parasites and pathogens, provide valuable control of several insect pests. For example, parasites often kill more than 80 percent of the budworms in tobacco fields, control similar to that obtained with foliar insecticides.

Hornworms are parasitized by Cotesia congregata whose larvae feed inside the caterpillars. When the larvae mature, they emerge through the backs of the hornworms and form egg-like cocoons. Tiny wasps emerge from these cocoons in a few days, mate, and seek out new hornworms to parasitize.

Stilt bugs are long-legged, slender, brown bugs that feed on hornworm and budworm eggs, aphids, and even small amounts of tobacco sap. Since stilt bugs feed on plant sap, systemic insecticides may kill them.

Aphids are attacked by the adults and larvae of several species of lady beetles, lacewings, and syrphid fly larvae, A red-colored midge larvae also feeds on aphids after topping. A pathogenic fungus fre-

quently controls aphids from July through September, especially in wet seasons. Although lady beetles, lacewings, and syrphid fly larvae are usually abundant on aphid-infested tobacco, they may not keep aphids below levels that will cause economic damage.

To preserve beneficial insects, scout fields and use economic thresholds to time insecticide applications and select insecticides with low impact on beneficials. These insecticides include Bacillus thuringiensis (Bt), pymetrozine (Fulfill), emamectin benzoate (Denim), spinosad (Tracer), and methomyl (Lannate). Transplant-water and tray-drench applications of imidacloprid (Admire Pro) and thiamethoxam (Platinum) have limited direct impact on beneficials.

Chemical control

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

INSECT CONTROL ON TRANSPLANTS PRODUCED IN THE GREENHOUSE

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

Ants can remove seeds from the trays and cause poor stands. **Cricket** feeding damage often destroys newly emerged tobacco seedlings, reducing stands and initial growth. **Shoreflies**, tiny flies that look like small houseflies, are frequently numerous in greenhouses. Their larvae (maggots) feed on young seedlings and may reduce stands during the first two weeks after germination. **Mice** also remove the seeds from float trays, seriously reducing plant stands. If stand loss is severe, the entire greenhouses must be reseeded due to this damage. In greenhouses with overhead watering systems, green **June beetle grub** may uproot seedlings in the trays.

Cutworms, crickets, vegetable weevils, and **slugs** usually feed on stems and leaves at night. **Cutworms** also cut off and destroy plants. **Crickets, cutworms, slugs**, and **yellow-striped armyworms** may destroy individual leaves on larger seedlings; this damage appears to do little harm. **Vegetable weevil** adults and larvae often feed on the leaves and stems and destroy the buds of seedlings.

Aphids often infest tobacco seedlings in the greenhouse building up high populations that reduce plant vigor, and they may be carried to the field on infested plants.

Cultural controls in the greenhouse

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

- As soon as transplanting has been completed, discard all unused plants and clean out the greenhouse.
- Keep the area in and around the greenhouse clean and free of weeds, decaying plant material, plastic, rocks, wood, metal, and other habitats for insects and other pests to live and feed.
- Do not plant fall and winter gardens near the greenhouse. Aphids can survive on various vegetables and related weeds during the winter and develop winged aphids that can fly into the greenhouse and establish colonies on the tobacco seedlings.
- If greenhouses are used to produce other crops, there should be a fallow period to keep pests from moving from the other crops to the tobacco seedlings. Whiteflies or aphids could become problems if they move from these earlier crops to tobacco.
- Use extreme temperatures to kill insects hiding in the greenhouse. Close the greenhouse in the summer to increase the temperature and promote cold temperatures in the winter to reduce potential pest problems.
- Seed the entire greenhouse at the same time. Do not seed tobacco in greenhouses that are infested with large numbers of shore flies because the shore flies will lay eggs on the seedlings and the larvae will injure the emerging seedlings, reducing stand and seedling uniformity
- Clean the greenhouse thoroughly just before seeding in the spring.

Chemical control in the greenhouse

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

Metaldehyde (Deadline Bullets) bait controls slugs and snails in the greenhouse. In the early evening, apply methaldehyde along walkways and the outside margins of the float beds. Do not apply methaldehyde directly to seedlings or use it in float beds. Mice should be controlled with baits labeled for their control.

Table 1. Insecticides for use on transplants grown in greenhouses

Insect	Insecticide and formulation	Rate per 1,000 sq ft
Aphids, cutworms, flea beetles	Acephate (Acephate AG) 75SP	1 tbs/3 gal of water (1 lb/acre)
	(Acephate) 97UP	0.75 tbs/3 gal of water (0.75 lb/acre)
	(Orthene) 97PE	0.75 tbs/3 gal of water (0.75 lb/acre)
	Remarks and precautions: Apply as a spray. Over application can cause plant injury. Do not apply through an irrigation system or in the float water.	
Snails and slugs	Metaldehyde (Deadline Bullets) 4% bait	0.25 to 0.5 lb
	Remarks and precautions: Slug damage is usually associated with shiny slime trails. Apply to alleys, walkways and vacant areas in late afternoon. Do not apply to float water or directly on foliage. It is deactivated by water.	
Ants	Acephate (Acephate AG) 75SP	1 oz/5 gal of water
	(Acephate) 97UP	
	(Orthene) 97PE	0.75 oz/5 gal of water
	Remarks and precautions: Apply 1 gal of mix to each mound area by sprinkling the mound until it is wet and treat a 4 ft diameter circle around the mound. Treat only once during the season.	

INSECT CONTROL ON NEWLY TRANSPLANTED TOBACCO

Wireworms

Wireworms are hard, yellowish-brown, wire-like larvae of click beetles that live in the soil, feeding on the roots and tunneling the piths of young tobacco plants. This injury stunts plant

growth, causing irregular stands and lower yields. Although wireworms feed throughout the growing season, the most serious damage occurs during the first month after transplanting. Wireworms take one to five years to complete their life cycle. Most of this time is spent in the larval stage. The larvae emerge from eggs in the summer and fall, feed on the roots of various host plants, and overwinter into the next year. Larvae then feed on the newly transplanted tobacco. Pupation and emergence as adult click beetles occurs in late spring and early summer.

Wireworms are most common in fields with a history of wireworm problems, or in those previously planted after grass sod, weeds, corn, or small grains. In these situations, apply an insecticide labeled as soil, tray-drench, or transplant-water treatments for wireworm control (Table 2). Apply soil insecticides (Lorsban or Mocap) as broadcast treatments and incorporate them at least two weeks before transplanting. Another option is to use Admire Pro or Platinum applied at the wireworm rates as transplant water or transplant-drench treatments. The most effective cultural practice for wireworm control is to use sturdy, healthy transplants that are less susceptible to wireworm damage than tender, young transplants. After wireworm damage has occurred, it is too late to apply an insecticide. Where damage is light to moderate, cultivation and irrigation may help injured plants recover and produce near normal yields although crop maturity may be delayed. If wireworms seriously reduce the stand replanting may be necessary. The field can be rebedded or turned under and replanted after a recommended soil insecticide is applied.

Cutworms

Cutworms are active at night, feeding on roots or leaves or cutting off entire plants. This injury can cause enough damage and stand loss to require replanting. However, since tobacco compensates well, less than 5 percent stand loss usually has no impact on yield. Cutworm infestations are very sporadic and difficult to predict, but they are most likely to occur in weedy fields that are plowed less than a month before transplanting. Plowing fields in the early spring usually reduces cutworm populations. Scout fields for cutworm damage once or twice a week during the first month after transplanting to determine when a remedial foliar treatment is needed (Table 8). For optimum control of this night-feeding pest, apply a foliar insecticide in the late afternoon or early evening when 5 percent or more of the plants in a field have recent cutworm damage.

Whitefringed beetles

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

Soil-incorporated insecticides

Pretransplant soil applications of insecticides can provide effective control of aphids, cutworms, flea beetles, wireworms, and nematodes on tobacco. However, foliar insecticides applied at the economic thresholds usually control insects feeding on the foliage and cost less than systemic insecticides applied to the soil.

Several factors should be considered before selecting a soil insecticide.

- Is there a field history of wireworms or nematode problems? If so, sample the field for nematodes as described in the disease control section of this guide and submit the samples to your local Extension office to be sent off for analysis. Fall sampling is best.
- If a tobacco field has been in sod, weeds, or small grains during the previous year or has a history of wireworm problems, apply an insecticide for wireworm control.
- Mocap, Capture, and Lorsban are broadcast soil treatments for wireworm control (Tables 2 and 3).
- Admire Pro or Platinum applied as transplant water or transplant drench treatments may be a better choice for wireworm control because they also control aphids and flea beetles (Tables 2, 4, and 5).
- Soil fumigants provide little control of insects in the soil or on the foliage because many insects are below the zone being fumigated.

Table 2. Ratings of soil, greenhouse tray drench, and transplant water treatments for control of insects and nematodes on burley tobacco.

	Leaf feeding insects		Soil insects		Nematodes [1]	
Insecticide	Aphids	Flea beetles	Cutworms	Wireworms	Root-knot and other	Tobacco Cyst
Acephate AG/TW[2]; Acephate UP; Orthene 97 (TW)[2]	2	3	3-4	0	0	0
Admire Pro/Nuprid (TW)[2]	5	2	0	3	0	0
Admire Pro/Nuprid (TD)[2]	5	4	0	3	0	0
Capture 2EC PPI, TPW	0	0	3	3	0	0
Lorsban 4E PPI	0	1	3	4	1 (5 qt/acre)	0
Mocap 6EC PPI	0	1	2-3	3-4	1	0
Platinum/TMOXX 2F (TW)[2]	5	3	0	3	0	0
Platinum/TMOXX 2F (TD)[2]	5	4	0	3	0	0

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

[1]Ratings for nematode control were made by Dr. Charles S. Johnson.
[2] TW = Transplant water, TD = Transplant drench, PPI=Preplant soil incorporated.

Table 3. Insects on field tobacco - pretransplant soil treatments

Insect	Insecticide and formulation	Rate per acre
Wireworms, Cutworms	Ethoprop	1.33 to
	(Mocap) 6EC	4 qt
	(Mocap) 15G	13 lb
	Chlorpyrifos (Lorsban) 15G	13.5 to 20 lb
	(Lorsban) 4E	2 to 3 qt
	Bifinthrin (Capture) 2EC	2.56 to 6.4 fl oz

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

Table 4. Insects on field tobacco - transplant-water treatments

Insect	Insecticide and formulation	Rate per acre or 1,000 plants
Flea beetles, cutworms, thrips, suppression of aphids	Acephate (Acephate AG) 75SP	1 lb/acre
	(Acephate) 97UP	0.75 lb/acre
	(Orthene) 97PE	0.75 lb/acre
Aphids, flea beetles	Imidacloprid (Admire Pro)	0-5 to 0.6 fl oz/ 1,000 plants
	4.6SC	
	(Nuprid) 2F	1.0 fl oz/ 1,000 plants
	Thiamethoxam	0.5 to 0.8 fl oz/1,000 plants
	(Platinum/TMOXX) 2SC	or 3 to 5 fl oz/acre
Wireworms, thrips for suppression of tomato spotted wilt virus	Imidacloprid (Admire Pro) 4.6SC	0.8 to 1.2 fl oz/ 1,000 plants
	(Nuprid) 2F	1.4-2.8 fl oz/ 1,000 plants
	Thiamethoxam	0.8 to 1.3 fl oz/1,000 plants
	(Platinum/TMOXX) 2SC	or 5 to 8 fl oz/acre

Remarks and precautions: Acephate provides flea beetle control for 3 to 4 weeks after transplanting and suppresses aphid infestations for 4 to 6 weeks. Admire Pro and Platinum usually gives 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.**

Table 5. Insects on field tobacco-drench application to greenhouse transplants

Insects	Insecticide and formulation	Rate per 1,000 plants
Aphids, flea beetles	Imidacloprid (Admire Pro) 4.6SC	0.5 to 0.6 fl oz/ 1,000 plants
	(Nuprid) 2F	1.0 fl oz/ 1,000 plants
	Thiamethoxam (Platinum) 2SC	0.5 to 0.8 fl oz
	(TMOXX) 2SC	
Wireworm, Thrips for suppression of tomato spotted wilt virus	Imidacloprid (Admire Pro) 4.6SC	0.6 to 1.2 fl oz/ 1,000 plants
	(Nuprid) 2F	1.4 to 2.8 fl oz/ 1,000 plants
	Thiamethoxam (Platinum) 2SC	0.6 to 1.3 fl oz
	(TMOXX) 2SC	0.6 to 1.3 fl oz

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

REMEDIAL CONTROL OF INSECTS ON LARGER TOBACCO

Scouting for Insects

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

1. Take representative samples from the entire field except for the outside rows. Take samples in Z or N patterns across the field. Do not sample the same plants each week. Look for insect pests and their damage on at least 50 plants in a field (1 to 10 acres). Make counts and record the data for five consecutive plants at ten locations throughout the field. Select the plants before you see them. If a field is planted on two different dates or if there are great differences in plant size within the field, divide the field into two or more sections and sample each section separately. Large fields (more than 10 acres) will require larger samples. Sample an additional ten plants for every 2 additional acres.
2. During the first four weeks after transplanting, check tobacco for feeding holes or missing, stunted, or cut plants. Cutworms, flea beetles, wireworms, and other insects may damage these plants.
3. Beginning about three to four weeks after transplanting, aphids, budworms, flea beetles, and hornworms are the primary targets of an insect scouting program.
4. When a field is being scouted for insects that feed on tobacco foliage, individual plants should be examined and recorded in a notebook as follows:
   a. Check the bud region for budworm damage. If damage is present, look carefully for budworms and the white cocoons of the budworms parasite, *Campoletis sonorensis*. If there is budworm damage, but no worm, do not count the plant as infested.
   b. Examine the entire plant for hornworm damage, locate, count the hornworms at least 1 inch long, and determine whether they are parasitized by *Cotesia congregate* (white egg-like cocoons on hornworm's back).

c. Examine the undersides of upper leaves for aphids and the upper surfaces of the middle and lower leaves for honeydew, flea beetles, flea beetle feeding holes, and mines of the tobacco splitworm.

d. If you find an unidentified insect that appears to be damaging the crop, collect the insect and samples of its damage, put them in a container, and take them to a local Extension agent for identification. This is important because beneficial insects are often mistaken for pests. In addition, the misidentification of a pest may lead to the selection of the wrong insecticide for its control.

5. Tobacco fields should be treated when one or more insect pests meet or exceed the threshold levels shown in Table 6.

Table 6. Economic thresholds for various insects on tobacco.

Insect	Economic threshold	Time when insect is a problem (weeks after transplanting)
Aphids	50 or more aphids on any upper leaf on 5 of 50 plants.	4 weeks after transplanting to final harvest
Budworms	10 plants with one or more budworm per 50 plants until 1 week before topping.	3 weeks after transplanting to 1 week before topping
Cutworms	5 out of 100 plants with recent cutworm damage.	1 to 4 weeks after transplanting
Flea beetles	4 beetles per plant on tobacco less than 2 weeks old, 8 to 10 beetles per plant on 2 to 4 week-old plants, 60 beetles per plant on plants more than 4 weeks old.	Transplanting to 4 weeks after transplanting and from topping to final harvest
Grasshoppers	10 grasshoppers per 50 plants.	6 weeks after transplanting to final harvest
Hornworms	5 larvae (worms) at least 1 inch long per 50 plants. Do not count parasitized worms with the egg-like cocoons on their backs. For hornworms 1/2 to 3/4 inch long, treat when there is 1 hornworm per plant.	3 weeks after transplanting to final harvest. Can be a problem on air-cured tobacco in curing structures.
Wireworms	Not determined	1 to 6 weeks after transplanting

Tobacco Budworms

Tobacco budworms feed in the buds of young tobacco plants causing many holes in the tiny developing leaves. As the leaves grow, these feeding holes become larger and give the plants a ragged, distorted appearance. Tobacco plants usually compensate for this damage so yield and quality may not be affected. However, budworms sometimes top the plants prematurely causing early sucker growth that may stunt the plants and require extra labor to remove the suckers. After the button stage, budworms rarely cause economic damage. Apply foliar sprays for budworm control with one or three solid-cone or hollow-cone nozzles over each row using 40 to 60 psi to deliver 10 to 25 gallons of spray mixture per acre. Control with foliar sprays rarely exceeds 80 percent. See insecticide performance ratings in Table 3 and insecticide options for budworm control in Table 8. When checking tobacco for budworms, look for the cocoons of a wasp (*Campoletis*) that parasitizes budworms on the leaves near the bud. These cocoons are about 1/4 inch long and white or grayish in color with two black bands or dots. *Campoletis* and other parasites provide good natural control of budworms on tobacco in Virginia.

Hornworms

Tobacco and tomato hornworms are large caterpillars (up to 4 inches long) that eat large amounts of tobacco leaf. Infestations may develop anytime from transplanting until harvest, but damage is usually most severe during August and September. Treat for hornworm control where there are five hornworms 1 inch long or longer per 50 plants. Do not count parasitized hornworms. Parasitized hornworms with the white egg-like cocoons of the parasitic wasp, *Cotesia congregata*, on their backs eat much less than healthy hornworms and they provide a food source for parasites that help reduce the next generation of hornworms. Predators also kill large numbers of larvae that are less than 1 inch long. For this reason, hornworms less than 1 inch long are not considered when determining the economic threshold because they cause very little damage and have no effect on yield or quality. However, if a field has large numbers of hornworms less than 1 inch long, the field should be rechecked in three to four days. For optimum control of hornworms, direct the spray to the upper one-half of the plants. See insecticide ratings in Table 3 and the labeled insecticides in Table 9. Several cultural practices help reduce the susceptibility of tobacco to hornworms. Early topping, early transplanting, effective sucker control, and fertiliza-

tion with recommended rates of nitrogen help reduce late-season infestations. When used on an area-wide basis, stalk cutting and root destruction immediately after harvest reduce overwintering hornworm populations.

Aphids

The tobacco or green peach aphid has been the most severe insect pest of tobacco in Virginia. Aphid populations increase rapidly, doubling in size in about every two days under favorable conditions. High populations of aphids can reduce tobacco yield by 5 percent to 25 percent (100 to 500 pounds per acre) or more. As aphids feed, they excrete honeydew that contains the excess sugars obtained from the plant sap. This sticky, shiny honeydew and tiny white exoskeletons are deposited on the leaves below the feeding aphids. A dark, sooty mold that gives the leaves a dark tint often grows on the honeydew. The combination of sooty mold and honeydew interferes with curing, reduces leaf quality, and often remains on tobacco after aphids have been controlled. Aphids are most severe on field tobacco from late June to September. Tobacco plants become infested when winged aphids fly into fields and deposit young wingless nymphs on the upper leaves. Watch for increases in aphid populations from early June to the end of August. Examine the undersides of leaves from all portions of tobacco plants to assess the extent of aphid infestation.

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

1. Preventive Control

a. **Apply systemic insecticides before or at transplanting**.

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

2. Remedial Control of Aphids

a. **Make remedial applications of a foliar insecticide at the economic threshold level** before populations become too high (Table 3). Aphids are then much easier to control for the rest of the season.

b. **Rotate insecticides for resistance management.** The continuous use of the same insecticide year after year increases the chances that aphids will develop resistance to it. Rotating insecticides with different modes of action reduces the chances that resistance will develop. The insecticides available for aphid control on tobacco are in several different groups based on their modes of action (the way they kill aphids). Orthene/ Acephate is in group 1b, Lannate is in group 1a, Fulfill is in group 9a; and Admire, Platinum, Nuprid, Provado, and Actara are in group 4a. When applying several insecticides for aphid control over the growing season, change from one group to another. Do not apply a neonicotinoid such as Provodo, Actara, or Assail to tobacco already treated with another neonicotinoid such as Admire or Platinum. Instead, apply Orthene or Fulfill because they are in different chemical groups.

c. **Assess control after three or four days.** It takes one to three days after application of most insecticides for the aphids to die. If control is not adequate, determine whether the weather conditions, spraying equipment, improper calibration, or other factors contributed to the poor control.

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

e. **Continue to scout the crop** after satisfactory control is obtained because aphid populations may return to damaging levels and require additional insecticide applications.

3. Cultural Control of Aphids

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

a. **Not planting cole crops such as cabbage and turnips near greenhouses.** These plants are sources of aphids that can infest tobacco plants early in the growing season.

b. **Controlling aphids in greenhouses.** Destroy greenhouse transplants immediately after transplanting is completed.

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

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

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

Tobacco Flea Beetle

Adult tobacco flea beetles feed on the leaves and stalks of tobacco, while the grubs or larvae feed on tobacco roots. Extensive feeding by both beetle stages on newly set transplants may cause stunting and uneven stands. When checking tobacco fields for flea beetles, look for the characteristic shot-hole feeding damage, and then count the beetles on 20 plants (two per field-sample location). **Apply treatments for flea beetles on newly set tobacco when there are four or more beetles per plant.** Larger plants can tolerate very high flea-beetle densities. Apply an insecticide when the base of the lower leaves have a netted appearance or densities exceed 60 beetles per plant. Flea-beetle control ratings for systemic and foliar insecticides are listed in Tables 2 and 7, respectively. Insecticides for flea-beetle control are listed in Tables 3, 4, 5, and 9). Harvesting at the normal time and stalk cutting and root destruction immediately after the last harvest are the most effective cultural practices for reducing flea-beetle damage. Tobacco with nitrogen deficiency appears to be more susceptible to flea-beetle damage after topping.

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

Managing thrips to control tomato spotted wilt virus

The tobacco thrips, *Frankliniella fusca*, is the primary vector of the tobacco pathogen, tomato spotted wilt virus (TSWV). TSWV caused serious stand reductions in tobacco fields in parts of Virginia in 2002 but it has occurred at very low rates since then. Foliar treatments for thrips control are not effective for managing TSWV after the disease is observed in the field. However,

tray drench or transplant water applications of Admire Pro and Platinum suppress TSWV. Tray drenches are more effective than transplant water treatments.

Tobacco splitworm

The tobacco splitworm, or potato tuberworm, is a leaf-mining caterpillar that is sometimes a late-season problem on tobacco. Splitworms live in tunnels or mines that appear as grayish, translucent blotches on the leaves. Splitworms can also feed in the midvein and stalk. Old mines turn brown and brittle and may destroy over 50 percent of the leaf. Although the mines are most common on the lower leaves, they can occur on any leaf. Splitworm damage increases the amount of dead leaf tissue and may reduce crop yield and value. Since splitworms feed within the leaves, they are difficult to control with insecticides. Currently, no insecticides are registered for splitworm control on tobacco. However, Denim, Tracer, and Acephate applied in high volumes of water provide fair to good control. Denim was the most effective treatment. Early-season applications of Warrior appear to be effective but are rarely necessary and no early-season thresholds have been established. Therefore, it is important to avoid planting or storing Irish potatoes near tobacco fields because they are an important source of this pest in tobacco. If splitworm mines are observed on the lower leaves, the leaves should be harvested and cured as soon as possible. Since splitworms continue to develop inside the leaves after they are harvested, removing infested leaves and dropping them on the ground will not reduce the problem and may make it worse.

INSECTICIDE APPLICATION METHODS

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

Table 7. Rating of foliar insecticides for control of insect pests on burley tobacco.

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

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

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

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

Insecticide	Restricted entry Intervals (REI) (hours)	Preharvest interval (PHI) (days)
Foliar treatments		
Acephate (Orthene/Acephate AG/Acephate UP)	24	3
Acetamiprid (Assail) 70WP, 30WG	12	7
Bacillus thuringiensis (Agree/Crymax/Dipel/ Javelin/XenTari)	4	0
Bacillus thuringiensis (Lepinox)	12	0
Bifenthrin (Capture)	12	Do not apply after layby
Carbaryl (Sevin)	12	0
Endosulfan (Golden Leaf Tobacco Spray/ Phaser/Thiodan)	24	5
Imidacloprid (Nuprid/Provado) 1.6F	12	14
Methomyl (Lannate)	48	7
Pymethozine (Fulfill)	12	14
Spinosad (Tracer)	4	3
Thiamethoxam (Actara/TMOXX))	12	14
Soil treatments		
Aldicarb (Temik) (Check label for reentry restrictions after first rainfall or irrigation)	48	Applied before transplanting
Bifenthrin (Capture)	12	Do not apply after layby
Chlorpyrifos (Lorsban)	24	“
Ethoprop (Mocap)	48	“
Metaldehyde (Deadline Bullets)	12	“
Greenhouse float tray or transplant water treatments		
Acephate (Orthene/Acephate)	24	Applied at or before transplanting
Bifenthrin (Capture)	12	Do not apply after layby
Imidacloprid (Admire Pro/Nuprid)	12	Applied at or before transplanting
Thiamethoxam (Platinum/TMOXX) 2F	12	“
Acephate (Orthene 97/Acephate 97UP)	24	“

INSECTS ON FIELD TOBACCO

Table 9. Insects on Field Tobacco - Foliar Treatments

Insect	Insecticide and formulation	Rate per acre
Aphids	Acephate (Acephate AG) 75SP (Acephate) 97UP	0.67 to 1 lb 0.5 to 0.75 lb
	(Orthene) 97PE	0.5 to 0.75 lb
	Remarks and precautions: Apply as a spray in 10 to 50 gal/acre. Use highest rate for heavy infestations or if control was poor with previous application. If tobacco is large and aphids are established on the lower leaves, drop nozzles that orient spray to undersides of leaves improve control. Prime before treating.	
	Acetamiprid (Assail) 70WP (Assail) 30WG	0.6 to 1.7 oz
	Remarks and precautions: Apply as a spray in at least 20 gal/acre. Do not apply to tobacco already treated with Admire Pro, Platinum, Provado, or Actara. Also provides fair control of hornworms.	
	Bifenthrin (Capture) 2EC	2.56 to 6.4 fl oz
	Remarks and precautions: Do not apply after layby. **Restricted use.**	
	Imidacloprid (Provado) 2F (Nuprid) 2F	2 to 4 fl oz 2 to 4 fl oz
	Remarks and precautions: Apply as spray. **Do not apply to tobacco treated with Admire Pro, Assail, Platinum, Provado, or TMOXX.**	
	Methomyl (Lannate) 90SP (Lannate) 2.4LV	0.25 to 0.5 lb 1.5 pt
	Remarks and precautions: Apply as a spray. Several applications may be necessary to control aphids. **Restricted Use**	
	Pymetrozine (Fulfill) 50WG 2.75 oz	
	Remarks and precautions: Do not apply more than 5.5 oz/acre/year. Allow 7 days between applications.	
	Thiamethoxam (Actara) 25WDG	2 to 3 oz
	Remarks and precautions: Do not apply to tobacco already treated with Platinum, TMOXX, AdmireAdmire Pro, Assail, or Provado. Apply only once during the growing season.	

Table 9. Insects on Field Tobacco - Foliar Treatments (Cont'd)

Insect	Insecticide and formulation	Rate per acre
Armyworms (beet, fall and yellowstripped)	Bifenthrin (Capture) 2EC	2.56 to 6.4 fl oz
	Remarks and precautions: Do not apply after layby. Restricted use.	
	Emamectin benzoate (Denim) 0.16EC	6 to 12 fl oz
	Remarks and precautions: Restricted Use. Apply in sufficient water for through coverage.	
	Lambda-cyhalothrin (Warrior) 1EC	1.9 to 3.8 fl oz
	Remarks and precautions: Restricted Use. Apply as a spray. Observe the 40-day preharvest interval. Orthene is labeled for armyworms on other crops.	
Budworms	Acephate (Acephate AG) 75SP (Acephate) 97UP (Orthene) 97PE	1 lb 0.75 lb 0.75 lb
	Remarks and precautions: Apply as a spray. When using hand sprayer apply in 10 to 50 gal/acre.	
	Bacillus thuringiensis Sprays (Agree) WG (Crymax) WG (Dipel) DF (Dipel) ES (Javelin) WG (Lepinox) WDG (XenTari) WDG	 1 to 2 lb 0.5 to 2 lb 0.5 to 1 lb 1 to 2 pt 1 to 1.25 lb 1 to 2 lb 0.5 to 2 lb
	Remarks and precautions: Apply as a spray. **Do not allow diluted sprays to stand in the sprayer more than 12 hours.**	
	Bifenthrin (Capture) 2EC	2.56 to 6.4 fl oz
	Remarks and precautions: Do not apply after layby. **Restricted use**.	
	Carbaryl (Sevin) 80S	1.25 to 2.5 lb
	(Sevin XLR Plus) 4F	1 to 2 qt
	Remarks and precautions: Apply as a spray. Do not apply until plants are established and growing. The tobacco aphid often becomes a problem on tobacco following two or more applications of Sevin.	

Table 9. Insects on Field Tobacco - Foliar Treatments (Cont'd)

Insect	Insecticide and formulation	Rate per acre
Budworms (cont'd)	Emamectin benzoate (Denim) 0.16EC	8 to 12 fl oz
	Remarks and precautions: Restricted Use. Apply in sufficient water for thorough coverage. Apply before damaging infestations occur.	
	Lambda-cyhalothrin (Warrior) 1EC	1.9 to 3.8 fl oz
	Remarks and precautions: Restricted Use. Apply as a foliar spray after field scouting indicates the population has reached the threshold as indicated by field scouting. Observe the 40-day preharvest interval.	
	Methomyl (Lannate) 90SP (Lannate) 2.4LV	0.5 lb 1.5 pt
	Remarks and precautions: Apply as a spray. Make applications as needed. Direct the spray into the buds before buttoning. **Restricted Use.**	
	Spinosad (Tracer) 4F	1.5 to 2 fl oz
	Remarks and precautions: Use higher rates for large larvae or high infestation. Use at least 20 gal of water per acre.	
Cabbage loopers	Acephate (Acephate AG) 75SP	1 lb
	(Acephate) 97UP	0.75 lb
	(Acephate) 97UP	0.75 lb
	(Orthene) 97PE	0.75 lb
	Remarks and precautions: Apply as a spray in 10 to 50 gal of water	
	Bacillus thuringiensis	
	See rates and formulations under budworms	
	Remarks and precautions: Apply as a spray. **Do not allow prepared sprays to stand in tank more than 12 hrs.**	
	Bifenthrin (Capture) 2EC	2.56 to 6.4 fl oz
	Remarks and precautions: Do not apply after layby. **Restricted use.**	

Table 9. Insects on Field Tobacco - Foliar Treatments (Cont'd)

Insect	Insecticide and formulation	Rate per acre
Cabbage loopers	Lambda-cyhalothrin (Warrior) 1EC	1.9 to 3.8 fl oz
	Remarks and precautions: Restricted Use. Apply as a spray. There is a 40-day preharvest interval.	
	Methomyl (Lannate) 90SP	0.5 lb
	(Lannate) 2.4 LV	1.5 pt
	Remarks and precautions: Apply as a spray. **Restricted Use.**	
	Spinosad (Tracer) 4F	1.5 to 2 fl oz
	Remarks and precautions: Apply as a spray in at least 20 gal of water per acre.	
Cutworms	Acephate (Acephate AG) 75SP (Acephate) 97UP	1 lb 0.75 lb
	(Orthene) 97PE	0.75 lb
	Remarks and precautions: Apply as a spray overtop of plants in affected areas when 5% of plants are injured by cutworms. Make application during late afternoon using at least 25 gal of spray per acre.	
	Bifenthrin (Capture) 2EC	2.56 to 6.4 fl oz
	Remarks and precautions: Do not apply after layby. **Restricted use.**	
	Lambda-cyhalothrin (Warrior) 1EC	1.9 to 3.8 fl oz
	Remarks and precautions: Restricted Use. Apply in the late afternoon when cutworms are causing damage. Do not apply within 40 days of harvest.	

Table 9. Insects on Field Tobacco - Foliar Treatments (Cont'd)

Insect	Insecticide and formulation	Rate per acre
Flea beetles	Acephate (Acephate AG) 75SP (Acephate) 97UP	0.67 lb 0.5 lb
	(Orthene) 97PE	0.5 lb
	Remarks and precautions: Apply as a spray. Prime before treating	
	Bifenthrin (Capture) 2EC	2.56 to 6.4 fl oz
	Remarks and precautions: Do not apply after layby. **Restricted use.**	
	Carbaryl (Sevin) 80S	1.25 lb
	(Sevin XLR Plus) 4F	1 qt
	Remarks and precautions: 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.	
	Imidacloprid (Provado) 1.6F	4 fl oz
	Remarks and precautions: Apply as spray. **Do not apply to tobacco already treated with Admire Pro, Assail, TMOXX, or Platinum.**	
	Lambda-cyhalothrin	1.9 to 3.8 fl oz
	(Warrior) 1EC	
	Remarks and precautions: Restricted Use. Apply in sufficient water for coverage.	
	Methomyl (Lannate) 90SP	0.25 to 0.5 lb
	(Lannate) 2.4LV	1.5 pt
	Remarks and precautions: Apply as a spray. **Restricted Use**.	
	Thiamethoxam (Actara) 25WDG	2 to 4 oz
	Remarks and precautions: Do not apply to tobacco already treated with Admire Pro, Assail, Platinum, Provado, or TMOXX. Apply only once during the growing season.	

Table 9. Insects on Field Tobacco - Foliar Treatments (Cont'd)

Insect	Insecticide and formulation	Rate per acre
Grasshoppers	Acephate (Acephate AG) 75SP (Acephate) 97UP	0.33 to 0.67lb 0.25 to 0.5 lb
	(Orthene) 97PE	0.25 to 0.5 lb
	Bifenthrin (Capture) 2EC	2.56 to 6.4 fl oz
	Remarks and precautions: Do not apply after layby. **Restricted use.**	
	Carbaryl (Sevin) 80S	0.67 to 1.88 lb
	(Sevin XLR Plus) 4F	0.5 to 1.5 qt
	Remarks and precautions: Apply as a spray. Treat crop and a strip around field to reduce grasshopper movement into the field.	
	Lambda-cyhalothrin	1.9 to 3.8 fl oz
	(Warrior) 1EC	
	Remarks and precautions: Restricted Use. Apply in sufficient water for coverage. There is a 40-day preharvest interval.	
Hornworms	Acephate (Acephate AG) 75SP (Acephate) 97UP (Orthene) 97PE	0.67 lb in water (1.5 tbs/gal of water 0.5 lb 0.5 lb (1 tbs/gal)
	Remarks and precautions: Apply as a spray. Treat infested fields before worms are more than 1-1/2 inches long. Direct insecticides toward the upper half of the plants. Prime before treatment.	
	Bacillus thuringiensis	
	(Agree) WSP	1 to 2 lb
	(Crymax) WG	0.5 to 2 lb
	(Dipel) DF	0.25 to 1 lb
	(Dipel) ES	0.5 to 1 pt
	(Javelin) WG	0.13 to 1.25 lb
	(Lepinox) WDG	1 to 2 lb
	XenTari WDG	0.5 to 2 lb
	Remarks and precautions: 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).	

Table 9. Insects on Field Tobacco - Foliar Treatments (Cont'd)

Insect	Insecticide and formulation	Rate per acre
Hornworms (cont'd)	Bifenthrin (Capture) 2EC	2.56 to 6.4 fl oz
	Remarks and precautions: Do not apply after layby. **Restricted use**.	
	Carbaryl (Sevin) 80S (Sevin XLR Plus) 4F	1.25 to 2.5 lb 1 to 2 qt
	Remarks and precautions: Apply as a spray.	
	Emamectin benzoate (Denim) 0.16EC	8 to 12 fl oz
	Remarks and precautions: Restricted Use. Apply in sufficient water for through coverage before damaging infestations occur.	
	Lambda-cyhalothrin (Warrior) 1EC	1.9 to 3.8 fl oz
	Remarks and precautions: Restricted Use. Apply as a spray. There is a 40-day preharvest interval.	
	Methomyl (Lannate) 90SP	0.25 to 0.5 lb
	(Lannate) 2.4LV	0.75 to 1.5 pt
	Remarks and precautions: Apply as a spray. **Restricted Use.**	
	Spinosad (Tracer) 4F	1 to 2 fl oz
	Remarks and precautions: Apply as a spray in at least 20 gal of water per acre.	

Table 9. Insects on Field Tobacco - Foliar Treatments (Cont'd)

Insect	Insecticide and formulation	Rate per acre
Japanese beetles	Acephate (Acephate AG) 75SP	0.67 to 1 lb
	(Acephate) 97UP	0.5 to 0.75 lb
	(Orthene) 97PE	0.5 to 0.75 lb
	Remarks and precautions: Apply as a spray in 10 to 50 gal/acre. Prime before treating.	
	Carbaryl (Sevin) 80S	1.25 lb or 3 tbs/ gal of water.
	(Sevin) 50W	2 lb
	(Sevin XLR Plus) 4F	1 qt
	Bifenthrin (Capture) 2EC	2.56 to 6.4 fl oz
	Remarks and precautions: Do not apply after layby. **Restricted use.**	
	Imidacloprid (Provado) 1.6F	4 fl oz
	Thiamethoxam (Actara) 25WDG	3 oz
	Remarks and precautions: Apply as a spray. Damage is usually less severe than it appears. Repeated applications with sevin or pyrethroids may flare up aphid.	
	Lambda-cyhalothrin	1.9 to 3.8 fl oz
	(Warrior) 1EC	
	Remarks and precautions: Restricted Use. Apply as a spray. There is a 40-day preharvest interval.	
Slugs	Metaldehyde (Dealine Bullets) 4 % Bait	12 to 40 lb/acre
	Remarks and precautions: Apply as a broadcast treatment to the soil surface in the late evening. Metaldehyde is most effective after irrigation or a rain.	
Stink bugs	Acephate (Acephate AG) 75SP	0.67 to 1 lb
	(Acephate) 97UP	0.5 to 0.75 lb
	(Orthene) 97PE	0.5 to 0.75 lb
	Remarks and precautions: Apply as a spray. Stinkbug injury is usually much less severe than it appears.	

Table 9. Insects on Field Tobacco - Foliar Treatments (Cont'd)

Insect	Insecticide and formulation	Rate per acre
Stink bugs (cont'd)	Bifenthrin (Capture) 2EC	2.56 to 6.4 fl oz
	Remarks and precautions: Do not apply after layby. **Restricted use**.	
	Lambda-cyhalothrin	1.9 to 3.8 fl oz
	(Warrior) 1EC	
	Remarks and precautions: Restricted Use. Apply as a spray. There is a 40-day preharvest interval. Restricted use.	
Thrips	Acephate (Acephate AG) 75SP	0.67 to 1 lb
	(Acephate) 97UP	0.5 to 0.75 lb
	(Orthene) 97PE	0.5 to 0.75 lb
	Remarks and precautions: Apply as a spray in 10 to 50 gal/acre. Use highest rate for heavy infestations or if control was poor with previous application. Prime before treating. Foliar applications for thrips control are not effective for reducing tomato spotted wilt virus after the disease is observed.	
	Bifenthrin (Capture) 2EC	2.56 to 6.4 fl oz
	Remarks and precautions: Do not apply after layby. **Restricted use**.	
	Lambda-cyhalothrin	1.9 to 3.8 fl oz
	(Warrior) 1EC	
	Remarks and precautions: Apply as a spray. Foliar applications for thrips control are not effective for reducing tomato spotted wilt virus after the disease is observed.. There is a 40-day preharvest interval.	
Whitefringed beetle	No chemical controls	
	Remarks and precautions: Cultural control: Rotate tobacco with grass crops. Control legumes and broadleaf weeds. **Do not plant tobacco after legumes.**	
	No insecticides are currently registered for whitefringed beetle control on tobacco	

HARVESTING, CURING, STRIPPING, AND MARKETING

Danny R. Peek, Extension Specialist, Burley Tobacco

Harvesting

Growers should only harvest mature, ripe tobacco. Burley tobacco usually matures and is ready for harvest three to five weeks after topping, at which time the upper one-third 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. There are also differences among varieties in time of maturing or ripening. Ms KY 14 x L8 is the earliest maturing variety available and NC 2000 is the latest maturing variety. Growers are often hesitant to allow the upper leaves to ripen for fear of losing some of the lower leaves. However, the added growth and weight of the upper leaves will usually more than make up for the loss of downstalk leaves. Generally, growers in the southwest portion of Virginia gain a tremendous amount of yield by waiting at least four to five weeks after topping before harvesting (Figure 1.). However, this may be different for burley growers in the piedmont area of Virginia. Yields are generally maximized at four weeks after topping and can start to decrease between four and five weeks after topping (Figure 2.). Thus, growers in the piedmont area should look at how long it will take to harvest their crop. If it can be harvested in week they should let the tobacco stand 4 weeks after topping. However, if it's going to take longer they should start at three weeks after topping. Burley tobacco should not be cut sooner than three weeks after topping.

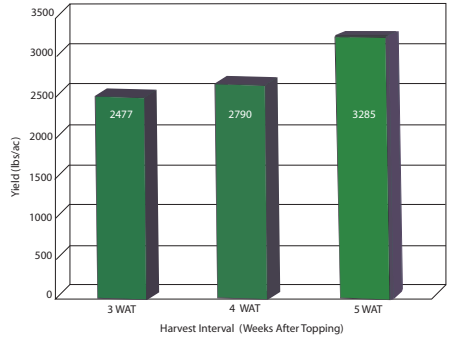


Figure 1. Burley tobacco yields averaged across ten varieties harvested three, four, and five weeks after topping. Glade Spring, 2006

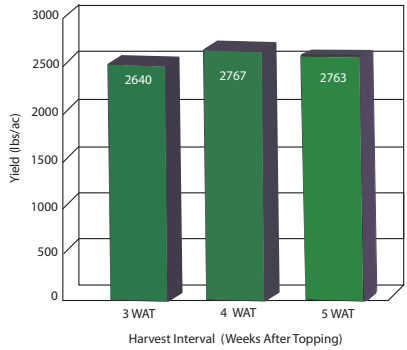


Figure 2. Burley tobacco yields averaged across ten varieties harvested three, four, and five weeks after topping, Blackstone, 2007

Currently there are several methods of cutting burley tobacco. Some growers allow the tobacco to be cut and placed in piles of five to six stalks, and then return to place this tobacco on a stick. Others use a 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 he or she goes through the field. Tobacco should be cut and speared onto a stick so that the butts of the plants are towards the sun to minimize sunburn damage. Sunburned tobacco can result in a cured leaf with an undesirable green color. Immature tobacco is much more likely to sunburn than mature tobacco.

Tobacco should not be left in the field longer than three to five 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 percent in weight.

Curing

Curing 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 the temperature is in the general range of 60° to 90°F and the relative humidity is 65 percent to 70 percent. 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 percent 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 microorganisms 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° to 8°F or just enough to dry the leaf surface and thereby prevent the proliferation of organisms that cause houseburn. Use some type of heat spreader on burners to prevent hot spots that can set undesirable colors in the curing leaf. Maximum temperature increases should not exceed 10° to 15°F. Heat can also be used to prevent setting green color by freezing on freshly harvested, late-cut tobacco. Few growers have the capability of adding heat and must rely on managing air flow.

Many curing problems can be relieved or prevented by properly manipulating the 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 environment 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 and managed.** Curing burley tobacco on curing structures without covering and management 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 when 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-price market in the early 1990s 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 or oblate tip. They are relatively thin bodied and show a certain amount of injury. The lug group (C) consists of leaves that grow above the flyings and up to about mid portion 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 three or four 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. Use no fewer than three groups when preparing any burley crop for market. Currently much of the burley purchased in Virginia is purchased through a contract rather than the auction system. Some manufactures will now require that tobacco be separated into 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, especially if tobacco is topped at 22 to 24 leaves. For pictures of burley grades and more information on grading burley tobacco go to the Southern Piedmont website, *arecs.vaes.vt.edu/arec.cfm?webname=blackstone*

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 overheat 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 (TSNAs). Moisture content should be between 18 percent and 22 percent for proper handling and storage. Many tobacco manufactures and leaf dealers will reject tobacco if above a moisture content of 23.9 percent.

EPA Worker Protection Standards for Commonly Used Pesticides for Burley Tobacco 2008

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The US-EPA Worker Protection Standard is a regulation that requires that you take actions 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 re-enter the field. 2) Protection against exposure must be ensured. Employers must provide personal protective equipment (PPE) 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 (REIs) (with some very specific exceptions). This may require careful scheduling of pesticide application and field work so that they do not conflict. PPE requirements vary from pesticide to pesticide and may be different for applicator/handlers and mixer/loaders. PPE is also required for entry into fields during the REI. Labels should be checked carefully for specific requirements. REIs 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. These include making available decontamination sites and emergency assistance in case of exposure.

The following table lists products, registration numbers, common names, REIs, 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]		Worker[4] Notification	
			Applicators and Other Handlers	To Enter Treated Area Within REI[3]	Oral	Posted
Acephate ® 75SP AG (acephate) EPA Reg. No. 51036-236 Micro Flo	Caution	24 hrs.	long-sleeve 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
Acephate 97UP EPA Reg. No. 70506-8 United Phosphorus						
Actara 25 WDG (thiamethoxam) EPA Reg. No. 100-938 Syngenta Crop Protection	Caution	12 hrs.	long-sleeve shirt, waterproof gloves, shoes plus socks	coveralls, waterproof gloves, shoes plus socks	either	either
Actigard ® 50WG (acibenzolar-S-methyl) EPA Reg. No. 100-922 Syngenta Crop Protection	Caution	12 hrs.	long-sleeve shirt and long pants; chemical-resistant gloves made of any waterproof material; shoes plus shoes	coveralls, chemical-resistant gloves made of any waterproof material shoes plus socks	either	either
Admire® Pro 4.6SC (imidacloprid) EPA Reg. No. 264-827 Bayer Crop Science	Caution	12 hrs.	long-sleeve shirt and long pants; waterproof gloves; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either
Agree® (*Bacillus thuringiensis* var. *aizawai strain)* EPA Reg. No. 70051-47 Certis USA	Caution	4 hrs.	long-sleeve shirt and long pants; waterproof gloves; shoes plus socks; protective eyewear; dust/mist filtering respirator	coveralls; waterproof gloves; shoes plus socks; protective eyewear	either	either

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE) [2]		Worker Notification[4]	
			Applicators and Other Handlers	To Enter Treated Area Within REI[3]	Oral	Posted
Aliette WDG Fungicide (*aluminum tris (o-ethylphsophonate)* EPA Reg. No. 264-516 Bayer CropScience	Caution	12 hrs.	Long-sleeve shirt and long pants; waterproof gloves, shoes plus socks; protective eyewear	coveralls, waterproof gloves, shoes plus socks, protective eyewear	either	either
Alias ® 2F (imidacloprid) EPA Reg. No. 264-758-66222 Makhteshim Agan of North America, Inc	Caution	12 hrs.	long-sleeve shirt and long pants, waterproof gloves, shoes plus socks, and chemical-resistant headgear for overhead exposure	coveralls, chemical-resistant gloves and shoes plus socks	either	either
Assail ® 70WP (acetamiprid) EPA Reg. No. 8033-23-4581 Cerexagri, Inc.	Caution	12 hrs.	long-sleeve shirt and long pants, waterproof gloves, shoes plus socks, and chemical-resistant headgear for overhead exposure	coveralls, chemical-resistant gloves and shoes plus socks	either	either
Assail ® 30WG EPA Reg. No. 8033-36-82695 **Brom-O-Gas®** (98% methyl bromide) EPA Reg. No. 5785-4, -42 Great Lakes Chemical	Danger	48 hrs. and gas concentra-tion less than 5 ppm	loose-fitting or well-ventilat-ed long-sleeve shirt and long pants; shoes and socks; full-face shield or safety glasses with brow and temple shields (NO GOGGLES); full-face respirator required when air concentration exceeds 5 ppm.	non-handlers prohibited	yes	yes

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE) [2]		Worker Notification[4]	
			Applicators and Other Handlers	To Enter Treated Area Within REI[3]	Oral	Posted
Butralin EPA Reg. No. 33688-4-400 Chemtura Corporation	Danger	12 hrs.	Long sleeve shirt, pants, chemical-resistant gloves, such as Vitron ≥ 14 mils shoes plus socks	Coveralls; chemical-resistant gloves such as laminate or Vitron ≥ 14 mils shoes plus socks, protective eyewear	either	either
Capture 2EC EPA (bifenthrin) EPA Reg. No. 279-3114 FMC Corporation **Capture LFR 1.5EC** EPA Reg. No. 279-3302	Warning	12 hrs.	long-sleeve shirt and long pants, chemical-resistance gloves, such as Barrier Laminate or Nitrile rubber or Vitron, shoes plus socks, and protective eyewear	coveralls, chemical-resistant gloves, such as Barrier Laminate or Nitrile rubber or Neoprene rubber or Vitron, and shoes plus socks	either	either
Chlor-O-Pic® (99% chloropicrin) EPA Reg. No. 5785-17 Great Lakes Chemical **Chloropicrin 100®** EPA Reg. No. 8536-02-8853 Hendrix and Dail, Inc.	Danger	48 hrs. and gas concen-tration less than 0.1 ppm	loose-fitting or well-ventilated long-sleeve shirt and long pants; shoes and socks; full-face shield or safety glasses with brow and temple shields. (DO NOT wear goggles, full-face respirator when air concentration exceeds 0.1 ppm)	non-handlers prohibited	yes	yes
Command ® 3ME EPA Reg. No. 279-3158 FMC CORPORATION EPA Reg. No. 279-3158-5905 Helena Chemical Co. EPA Reg. No. 279-315-34704 UAP-Loveland Products, Inc. EPA Reg. No. 279-3158-55467 Tenkoz, Inc.	Caution	12 hrs.	long-sleeve shirt and long pants; chemical-resistant gloves, such as Barrier Laminate, Butyl or Nitrile rubber, or Viton; shoes plus socks.	coveralls; chemical-resistant gloves, such as Barrier Laminate, Butyl or Nitrile rubber or Viton; and shoes plus socks.	either	either

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE) [2]		Worker Notification[4]	
			Applicators and Other Handlers	To Enter Treated Area Within REI[3]	Oral	Posted
Crymax® *(Bacillus thuringiensis)* EPA Reg. No. 70051-86 Certis USA	Caution	4 hrs.	long-sleeve shirt and long pants; shoes plus socks; and dust/mist filtering respirator	coveralls; waterproof gloves; shoes plus socks; and protective eyewear	either	either
Deadline Bullets 4G (metaldehyde) EPA Reg No. 64864-00002-AA-00000 Pace International	Caution	12 hrs.	long-sleeve shirt and long pants; shoes plus socks	long-sleeve shirt; shoes plus socks	either	either
Denim 0.16EC (emamectin benzoate) EPA Reg. No. 100-903 Syngenta Crop Protection	Danger	48 hrs.	coveralls worn over long-sleeve shirt and long pants, chemical-resistant gloves, chemical-resistant footwear plus socks, protective eyewear, chemical-resistant apron when cleaning equipment, mixing, or loading	coveralls over long-sleeve shirt and long pants, chemical-resistant gloves, chemical-resistant footwear 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]		Worker Notification[4]	
			Applicators and Other Handlers	To Enter Treated Area Within REI[3]	Oral	Posted
Devrinol 2-EC (napropamide) EPA Reg. No. 70506-64 United Phosphorus, Inc.	Danger	12 hrs.	long-sleeve shirt and long pants; chemical-resistant gloves such as Barrier Laminate or Viton ≥ 14 mils; shoes plus socks; protective eyewear	coveralls; chemical-resistant gloves such as Barrier Laminate or Viton ≥ 14 mils; shoes plus socks; protective eyewear	either	either
Devrinol® 50-DF (napropamide) EPA Reg. No. 70506-36 United Phosphorus, Inc.	Caution	12 hrs.	long-sleeve shirt and long pants; chemical-resistant gloves, shoes plus socks	coveralls; chemical-resistant gloves; shoes plus socks	either	either
Dipel® DF EPA Reg. No. 275-103 Valent **Dipel® ES** EPA Reg. No. 73049-17	Caution	4 hrs.	long-sleeve shirt and long pants; waterproof gloves; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either
Dithane® DF Rainshield (mancozeb) EPA Reg. No. 62419-402 SLN No. VA940001 Dow AgroSciences LLC	Caution	24 hrs.	coveralls over long-sleeve shirt and long pants; chemical-resistant gloves; shoes plus socks	coveralls over long-sleeve shirt and long pants; chemical-resistant gloves; shoes plus socks	either	either
Fair 85® (C6 - C12 fatty alcohols) EPA Reg. No. 51873-7 Fair Products	Warning	24 hrs.	long-sleeve shirt and long pants; chemical-resistant gloves such as Barrier Laminate or butyl rubber or nitrile rubber or neoprene or polyvinyl chloride or Viton; shoes plus socks; protective eyewear	coveralls; chemical-resistant gloves such as Barrier Laminate or butyl rubber or nitrile rubber or neoprene or polyvinyl chloride or Viton; shoes plus socks; protective eyewear	either	either

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2]		Worker Notification[4]	
			Applicators and Other Handlers	To Enter Treated Area Within REI[3]	Oral	Posted
Fair Plus® (maleic hydrazide) EPA Reg. No. 51873-2 Fair Products	Caution	12 hrs.	long-sleeve shirt and long pants; waterproof gloves; shoes plus socks; protective eyewear	coveralls; waterproof gloves; shoes plus socks; protective eyewear	either	either
Forum (dimethomorph) EPA Reg. No. 241-427 BASF Corporation	Caution	12 hrs.	long-sleeve shirt and long pants; chemical-resistant gloves; shoes plus socks	long-sleeve shirt and long pants; chemical-resistant gloves; shoes plus socks	either	either
FST-7® (C10 fatty alcohol and maleic hydrazide) EPA Reg. No. 51873-6 Fair Products	Danger	24 hrs.	long-sleeve shirt and long pants; chemical-resistant gloves such as Barrier Laminate or butyl rubber or nitrile rubber or neoprene or polyvinyl chloride or Viton; shoes plus socks; protective eyewear	coveralls; chemical-resistant gloves such as Barrier Laminate or butyl rubber or nitrile rubber or neoprene or polyvinyl chloride or Viton; shoes plus socks; protective eyewear	either	either
Fulfill® 50WDG (pymetrozine) EPA Reg. No. 100-192 Syngenta Crop Protection	Caution	12 hrs.	coveralls; chemical-resistant waterproof gloves, shoes plus socks	coveralls; chemical-resistant gloves waterproof, shoes plus socks	either	either

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

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE) [2]		Worker Notification[4]	
			Applicators and Other Handlers	To Enter Treated Area Within REI[3]	Oral	Posted
Lorsban® 4E (chlorpyrifos) EPA Reg. No. 62719-220	Warning	24 hrs.	long-sleeve shirt and long pants; chemical-resistant gloves; shoes plus socks	coveralls; chemical-resistant gloves; shoes plus socks	yes	yes
Nuprid 2F (imidacloprid) EPA Reg. No. 228-484 Nufarm Americas, Inc **Nuprid 1.6F** EPA Reg. No. 228-488	Caution	12 hrs.	long-sleeve shirt and long pants; waterproof gloves; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either
Off-Shoot T® (C6 - C12 fatty alcohols) EPA Reg. No. 57582-3 Cochran	Warning	24 hrs.	long-sleeve shirt and long pants; waterproof gloves; shoes plus socks; protective eyewear	coveralls; waterproof gloves; shoes plus socks; protective eyewear	either	either
Orthene® 75S (acephate) EPA Reg. No. 59639-26 **Orthene ® 97** EPA Reg. No. 59639-91 Valent	Caution	24 hrs.	long-sleeve 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

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2]		Worker Notification[4]	
			Applicators and Other Handlers	To Enter Treated Area Within REI[3]	Oral	Posted
Pasada ® 1.6 F (imidacloprid) EPA Reg. No. 264-763-6622 Makhteshim Agan of North America, Inc	Caution	12 hrs.	long-sleeve shirt and long pants, waterproof gloves; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either
Pic Plus (chloropicrin) EPA Reg. No. 8853-6 Hendrix and Dail, Inc.	Danger	48 hrs.	coveralls or loose-fitting or well-ventilated long-sleeve shirt and long pants; shoes and socks; full-face shield or safety glasses with brow and temple shields (DO NOT wear goggles); full-face respirator when air concentration exceeds 0.1 ppm	non-handlers prohibited	yes	yes
Platinum ® 2SC (thiamethoxam) EPA Reg. No. 100-939 Syngenta Crop Protection	Caution	12 hrs.	long-sleeve shirt, waterproof gloves, shoes plus socks	coveralls, shirt, waterproof, gloves, shoes plus socks	yes	yes
Poast® (sethoxydim) EPA Reg. No. 7969-58-51036 SLN No. VA-980004 Micro Flo Co., LLC	Warning	12 hrs.	coveralls over short-sleeved shirt and short pants; chemical-resistant gloves ≥14 mils; chemical-resistant footwear plus socks; protective eyewear; chemical-resistant headgear for overhead exposure; chemical-resistant apron when cleaning equipment, mixing, and loading	coveralls over short-sleeved shirt and short pants; chemical-resistant gloves ≥14 mils; chemical-resistant footwear plus socks; protective eyewear; chemical-resistant headgear for overhead exposure	either	either

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2]		Worker Notification[4]	
			Applicators and Other Handlers	To Enter Treated Area Within REI[3]	Oral	Posted
Prep® (ethephon) EPA Reg. No. 264-418 Bayer CropScience	Danger	48 hrs.	coveralls over short-sleeved shirt and short pants; waterproof gloves; protective eyewear; chemical-resistant footwear plus socks; chemical-resistant headgear for overhead exposures; chemical-resistant apron when cleaning equipment	coveralls over short-sleeved shirt and short pants; waterproof gloves; protective eyewear; chemical-resistant footwear plus socks; chemical-resistant headgear for overhead exposures	yes	yes
Prime+® (flumetralin) EPA Reg. No. 100-640 Syngenta Crop Protection	Danger	24 hrs.	coveralls over short-sleeved shirt and short pants; chemical-resistant gloves such as Barrier Laminate or Viton; chemical-resistant foot-wear plus socks; protective eyewear; chemical-resistant headgear for overhead exposure; chemical-resistant apron when cleaning equip-ment, mixing or loading	coveralls over short-sleeved shirt; short pants; chemical-resistant gloves such as Barrier Laminate or Viton; chemical-resistant footwear plus socks; protective eyewear; chemical-resistant headgear for overhead exposure	either	either
Provado 1.6F (imidacloprid) EPA Reg. No. 3125-457 Bayer Crop Protection	Caution	12 hrs.	ong-sleeve shirt and long pants, waterproof gloves; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2]		Worker Notification[4]	
			Applicators and Other Handlers	To Enter Treated Area Within REI[3]	Oral	Posted
Prowl® 3.3 (pendimethalin) EPA Reg. No. 241-337 BASF Corp. **Prowl® H_20** (pendimethalin) EPA Reg. No. 241-418 BASF Corp. **Pendimax 3.3** EPA Reg. No. 68156-6-62719 Dow AgroSciences LLC	Caution	24 hrs	long-sleeve shirt and long pants; chemical-resistant gloves such as Barrier Laminate or Viton >14 mils; shoes plus socks	coveralls; chemical-resistant gloves such as Barrier Laminate or Viton >14 mils; shoes plus socks	either	either
Quadris (azoxystrobin) EPA Reg. No. 100-1098 Syngenta Crop Protection	Caution	4 hrs	long-sleeve 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 Crop Protection **Ridomil Gold SL ®** (mefenoxam) EPA Reg. No. 100-1202	Caution	48 hrs	long-sleeve shirt and long pants, chemical-resistant gloves, shoes plus socks	coveralls, chemical-resistant gloves, shoes plus socks	either	either

Product Trade Name (common name) EPA Reg. No. Company Name	Personal Protective Equipment (PPE) [2]				Worker Notification[4]	
	Signal Word	Restricted Entry Interval (REI)[1]	Applicators and Other Handlers	To Enter Treated Area Within REI[3]	Oral	Posted
Royal MH-30® (maleic hydrazide) EPA Reg. No. 400-84 Uniroyal Chemical	Caution	12 hrs	long-sleeve 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 Bayer CropScience	Caution	12 hrs	long-sleeve shirt and long pants; chemical-resistant gloves such as Barrier Laminate, butyl rubber, nitrile rubber, neoprene rubber, polyvinyl chloride (PVC), or Viton; shoes plus socks and chemical-resistant headgear for overhead exposure	coveralls; chemical-resistant gloves such as Barrier Laminate, butyl rubber, nitrile rubber, neoprene rubber, polyvinyl chloride (PVC), or Viton; shoes plus socks and chemical-resistant headgear for overhead exposure	either	either
Sevin® 80S (carbaryl) EPA Reg. No. 264-316 Bayer CropScience	Warning	12 hrs	long-sleeve 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
Spartan ® 4F (sulfentrazone) EPA Reg. No. 279-3220 FMC Corporation	Caution	12 hrs	long-sleeve shirt and long pants; waterproof gloves; shoes plus socks	coveralls over long-sleeve 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]		Worker Notification[4]	
			Applicators and Other Handlers	To Enter Treated Area Within REI[3]	Oral	Posted
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-sleeve shirt and long pants; shoes plus socks; waterproof gloves	coveralls; waterproof gloves; shoes plus socks	either	either
Telone® C-17 (1,3-Dichloropropene and Chloropicrin) EPA Reg.No. 62719-12 Dow AgroSciences LLC	Danger	5 days	see label for extensively detailed instructions for PPE	Non-handlers prohibited; see label for extensive instructions for handlers	yes	yes
Telone® II (1,3-Dichloropropene) EPA Reg. No. 62719-32 Dow AgroSciences LLC	Warning	5 days	see label for extensively detailed instructions for PPE	Non-handlers prohibited; see label for extensive instructions for handlers	yes	yes

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE) [2]		Worker Notification[4]	
			Applicators and Other Handlers	To Enter Treated Area Within REI[3]	Oral	Posted
Terramaster 4EC (etridiazole) EPA Reg. No. 400-422 Chemtura USA Corporation	Danger	12 hrs	long-sleeve shirt and long-pants, chemical-resistant gloves such as barrier laminate or viton, shoes plus socks, NIOSH approved respirator, chemical-resistant apron when mixing, etc.	coveralls, chemical-resistant gloves such as barrier laminate or viton, shoes plus socks, protective eyewear	yes	yes
TMOXX ® 2SC (thiamethoxam) EPA Reg. No. 100-939-51873 Fair Products	Caution	12 hrs	long-sleeve shirt, waterproof gloves, shoes plus socks	coveralls, shirt, waterproof, gloves, shoes plus socks	yes	yes
Tracer® 4 (spinosad) EPA Reg. No. 62719-267 SLN No. VA980001 Dow AgroSciences	Caution	4 hrs	long-sleeve 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	48 hrs	long-sleeve shirt and long pants, chemical-resistant gloves, shoes plus socks, protective eyewear	coveralls, chemical-resistant gloves, shoe plus socks, protective eyewear	yes	yes
Warrior (lambda-cyhalothrin) EPA Reg. No. 100-1112 Syngenta	Warning	24 hrs	long-sleeve shirt and long pants, chemical-resistant gloves, shoes plus socks, protective eyewear	coveralls, chemical-resistant gloves, shoes, plus socks	either	either

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2] Applicators and Other Handlers	Personal Protective Equipment (PPE)[2] To Enter Treated Area Within REI[3]	Worker Notification[4] Oral	Worker Notification[4] Posted
XenTari® WDG *(Bacillus thuringiensis)* EPA Reg. No. 275-85 Valent	Caution	4 hrs	long-sleeve shirt and long pants; waterproof gloves; shoes plus socks; dust/mist filtering respirator (MSHA/NIOSH approved number prefix TC-21C)	coveralls; waterproof gloves; shoes plus socks	either	either

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

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

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

4. **Notification on Farms, Forests, and Nurseries:** Refer to page 41, The Worker Protection Standard for Agricultural Pesticides—How to Comply. Unless the pesticide labeling requires both types of notification, notify workers either orally or by posting of warning signs at entrances to treated areas. You must inform workers which method of notification is being used.
Both Oral Warning and Posted Signs: Some pesticide labels require you to notify workers both orally and with signs posted at entrances to the treated area. If both types of notification are required, the following statement will be in the "Directions for Use" section of the pesticide labeling under the heading Agricultural Use Requirements: "Notify workers of the application by warning them orally and by posting warning signs at entrances to treated areas."

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