2011

BURLEY TOBACCO

PRODUCTION GUIDE

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Virginia Cooperative Extension

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VSU Virginia State

in cooperation with

Burley Stabilization Corporation

2011 BURLEY TOBACCO

PRODUCTION GUIDE

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Cover design by Tim FisherPoff.

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Extension Personnel Working With Burley Tobacco

The following are the county Extension Service personnel with burley tobacco responsibility as of January 1, 2011.

County	Name	Telephone
Bland	Jim Atwell	276-688-3542
Dickenson	Brad Mullins	276-926-4605
Grayson	Kevin Spurlin	276-773-2491
Lee	Scott Jerrell	276-346-1522
Montgomery	Vacant	540-382-5790
Patrick	Travis Bunn	276-694-3989
Russell	Scott Jessee	276-889-8056
Scott	Scott Jerrell	276-452-2772
Smyth	Andy Overbay	276-783-5175
Washington	Phil Blevins	276-676-6309
Piedmont Counties		
Appomattox	Bruce Jones	434-352-8244
Campbell	Scott Reiter	434-332-9538
Charlotte	Bob Jones	434-542-5884
Franklin	Tim Johnson	540-483-5161
Mecklenburg	Taylor Clarke	434-738-6191
Pittsylvania	Stephen Barts	434-432-7770
Prince Edward	Vacant	434-392-4246

AGRONOMIC INFORMATION

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

TRANSPLANT PRODUCTION

The production of an ample supply of uniform, healthy plants that are available reasonably early in the transplanting season is the first step for a successful crop. The best practice is to produce your own transplants. Doing so will reduce the likelihood of importing disease and pest problems onto your farm. The next best alternative is to buy transplants from someone in your local community. If you must import transplants, purchasing certified disease free transplants is strongly recommended.

An outline of plant bed management practices which have proven to be effective over the years is given below. If these suggestions are followed, most of the risks in plant production should be reduced or eliminated.

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

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

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

4. Fumigate soil with methyl bromide when soil moisture is right for cultivation and the air temperature is 55^0F or higher, preferably in the fall.

5. Apply 50 lbs. of 12-6-6 fertilizer per 100 sq. yds. and disc into top 2 to 3 inches of soil. If extra nitrogen is needed, 3-6 pounds of calcium nitrate (15.5-0-0) per 100 sq. yds. can be used as a top dressing. To avoid plant injury and possible loss of transplants organic forms of nitrogen are not suggested for use on plant beds.

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

7. Beds covered with porous materials (Reemay, cotton, etc.) should be watered frequently in dry weather. Frequent, light applications during the germination period often mean the difference between a good stand and plant bed failure. One-fourth inch (about 140 gallons per 100 square yards) every other day should be sufficient for germination and establishment of plants. As the plants develop in size, about 1/2 inch of water twice a week is usually adequate. Water should be applied slowly enough so that it is absorbed and the force of the water does not dislodge seedlings. Plant beds should be watered when the soil is dry, regardless of the temperature. Plants can perish in cold weather as well as warm weather.
8. Control diseases and insects using only approved chemicals.
9. Consider clipping beds two to four times about five days apart beginning at a height of four inches and ending at a height of eight inches to improve plant uniformity and/or delay growth of plants. Clip approximately 1/2 inch above the bud of the largest plants.

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

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

PLANT BED MECHANIZATION

Narrow-raised Plant Beds

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

Mechanical Seeding

Mechanical seeding that will insure a uniform rate of seed is becoming more popular in tobacco transplant production. Most precision seeded beds utilize pelleted or coated seed that can be metered for specific seed spacing.

Commercial seed companies are now marketing pelleted seed of most popular varieties. The Stanhay Precision planter has been used most frequently and has given good results.

Clipping Plants

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

Clipping can be accomplished with a modified high suction lawn mower or a tractor-mounted rotary mower with rear mounted gauge wheels. Tractor-mowed mowers work best on narrow (6 ft wide), raised plant beds, but can be used on wide (15 ft) beds by running one set of wheels down the center of the bed.

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

VARIETIES

Danny R. Peek, Extension Specialist, Burley Tobacco

Carol A. Wilkinson, Associate Professor, Agronomy

Virginia Tech evaluates burley tobacco breeding lines through the minimum standards programs and burley varieties through the Virginia Official Variety Test conducted at both Southwest Virginia and Southern Piedmont Agriculture Research and Extension Centers.

The Regional Minimum Standards Program insures that varieties being used in commercial production are acceptable by the tobacco industry. Once a breeding line is genetically stable, it can be entered into the Regional Preliminary Test (RPT). Breeding lines that pass the minimum standards for chemical quality in the RPT are eligible for entry into the Regional Quality Test (RQT). If a breeding line passes the RQT, which includes a smoke panel evaluation, it is eligible for release as a commercial variety. Both the RPT and the RQT are conducted cooperatively by university personnel at Kentucky, Tennessee, North Carolina, and Virginia.

Selecting the right burley tobacco variety for your farm is one of the most important decisions in producing a profitable crop. Individual farmers have different requirements for the variety or varieties grown on their farm. Requirements for disease resistance, yield potential, ease of growing, maturity, curing, and market acceptance should be considered when selecting a burley tobacco variety. Another important consideration for growers in the piedmont area of Virginal 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 in yield and not decrease 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, virus complexes are the diseases that result in the most significant yield losses for burley tobacco. For all these disease problems we have some level of varietal resistance. However, there is currently no one variety that 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 a 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, a variety with at least medium resistance should be selected. Burley varieties are rated for black shank resistance on a numerical scale. The numerical ratings range from 0 to 10 with 0 meaning no resistance and 10 meaning very high 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. Some of the yield loss was simply due to yield potential of resistant varieties compared to non resistant varieties. For the most part, this has been eliminated with the recent release of burley varieties KT 209LC, KT 206LC and KT 204LC.

A brief description of some of the newest released varieties will help grower become familiar with the attributes of each variety.

KT 210LC was released jointly by the University of Kentucky and University of Tennessee. This variety was primarily released for specific growers combating Fusaurium Wilt. This is the only variety that possesses both moderate fusarium wilt and high black shank resistance. KT 210LC has black shank resistance, comparable to KT 206 LC. KT 210LC does not have resistance to the "virus complexes" such as etch and vein mottling viruses Yield potential may be less than KT 206 LC but greater than TN 90LC. Limited research has shown that KT 210LC has good cured leaf quality.

KT 209LC was released jointly by the university of Kentucky and University of Tennessee. This variety has similar disease package as KT 206 LC with one primary advantage being improved black shank resistance. KT 209LC has the highest level of black shank resistance of any commercially available burley variety. 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 8 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 206LC was released jointly by the University of Kentucky and University of Tennessee and offers some improvements. KT 206 LC has a good overall disease package, but primarily good black shank resistance to both races. 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 7371LC was released by Newton Seeds Inc. in 2007. Early indications are that resistance to black shank early 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 404LC was released by Clays Seed Incorporated for the 2008 season. It is a high yielding, semi-upright, and medium green in color. Hybrid 404LC seems to hold up very well under drought conditions. It is reported to have black root rot resistance which is an improvement over Hybrid 403 LC. The purpose of this variety was to replace Hybrid 403LC. This variety does not have black shank resistance and should not be used in fields with a history of black shank or fields where resistant varieties have been grown for several years. Yield potential is expected to be similar to Hybrid 403 LC.

HB 3307PLC was 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 204LC was released jointly by the University of Kentucky and University of Tennessee. It is a moderatley late maturing hybrid with high yield potential. KT 204 is moderately high resistant 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, would be a better choice for controlling black shank. KT 204 is not as tolerant to blue mold as is TN 90.

NC 7 was developed and released by North Carolina State University. 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 good in the piedmont area of Virginia compared to many other varieties. Seed is available from Gold Leaf and Workman Seed Companies.

NC 2002 was released by North Carolina State University. It has moderate yield potential of high quality cured leaf. NC 2002 has good blue mold resistance very similar to NC 2000. NC 2002 is late maturing but about 5-7 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.

Burley tobacco agronomic characteristics of varieties tested at the Southwest Virginia Agricultural Research and Extension Center in 2007 are shown in Table 1. Disease resistance of burley varieties are discussed in the disease section of the production guide.

Although quality has always been important in burley tobacco production it seems essential now for growers to sustain the marketability of their crop. Growers have been encouraged to put much thought into the quality characteristics of a variety when making variety selections. However, generally there are only very subtle differences in quality among varieties (Table 2). 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, VA, 2007.

Cultivar or Line	Yield lbs/A	Plant height inches	Leaf no.	Days to flower	Top Leaf L --inches--	Top Leaf W --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

Table 2. Relative quality ratings for burley tobacco varieties from four locations 2006-2008.

Variety	Quality Index Rating
KT 210LC	63
NC 2002LC	63
TN 86LC	63
N 7371LC	62
TN 90LC	62
KT 206LC	61
KT 204LC	61
TN 97LC	61
KT 209LC	60
NC 7LC	57
KY 14 X L8LC	56

Quality Index is based on Federal Grades; higher values represent higher quality

Data from studies by the University of Kentucky and the University of Tennessee tobacco breeding program.

Table 3. Relative yield of burley tobacco varieties across four locations in 2008 – 2009 .

Variety	Relative Yield Rating 0 – 10*	Disease Free Yield 12 Replications
Hybrid 404LC	9	3122
HB 04PLC	8	3041
NC 7	9	3009
KT 206LC	9	2999
KY 14 X L8LC	7	2995
HP 3307PLC	8	2911
KT 204LC	9	2906
KT 209LC	9	2892
KT 210LC	8	2873
N 7371	7	2861
TN 97LC	6	2791
NC 2002	5	2786
TN 90LC	5	2717
TN 86LC	*7*	*2652*

*Higher values indicate higher yield potential.
Data from studies conducted by the University of Kentucky and the University of Tennessee tobacco breeding program.

TRANSPLANTING AND SPACING

The time of transplanting is largely dependent upon when the plants reach transplant size. It is good to plan to have the plants ready for transplanting about May 15. Early transplanting, before June 1, is preferred to a later planting because moisture conditions for quick, early growth are usually better, and generally early curing conditions are more desirable. Good stocky plants with a healthy root system are most essential to obtaining a full stand without replanting. Plants 6" to 8" in length with stems about the diameter of a pencil live better and grow more rapidly than the smaller or larger plants.

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

Some suggestions which may be helpful are:

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

SPACING CHART - PLANTS PER ACRE

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

EFFECT OF SPACING

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

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

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

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

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

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

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

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

tobacco from the wider spacing to be heavier in body. Tobacco produced from the 24" spacing was slightly better in color.

FERTILIZATION

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

Nutrient Rates

The first step in determining fertilizer needs is a soil test. It will indicate the level of phosphorus and potassium in the soil and aid in determining if lime is needed to keep the pH in the desirable range (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, the following factors should be considered in determining fertilizer rates:

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

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

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

Soil Test Level	Fertilizer Recommendations (lb/A)		
	N	P_2O_5	K_2O
L	175-200	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 are necessary to produce high yields of good quality burley tobacco.

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

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

	Preplant Nitrogen (lbs N/acre)		
Sidedress 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 9 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 nutrient used most excessively in tobacco fertilization in Virginia. Repeated applications of larger quantities of phosphorus than plants can absorb, and with essentially no loss from leaching, has resulted in a general buildup of this element. Fertilizer sales indicate that about twice as much phosphorus is generally used on tobacco as needed. Based on a summary of soil analyses of tobacco fields by the Virginia Tech Soil Testing Laboratory, approximately 88% of the soils had a medium or higher phosphorus level. Present research indicates that 40 to

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

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

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

Since high levels of chlorine in tobacco can result in poor curing and poor leaf characteristics ("wet dog"), it is preferable to use non-chlorine sources of potash, i.e. potassium sulfate (0-0-50). Or potassium nitrate (13-0-44). *Don't use muriate of potash* (0-0-60). No more than 30 pounds of chlorine per acre should be applied to burley tobacco.

Selecting the Fertilizer Grade

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

Nutrients Contained In:

	Amount	lbs/A		
Analysis	lbs	N	P_2O_5	K_2O
5-10-15	1000	50	100	150
8-16-24	1000	80	160	240
10-6-18	1000	100	60	180
11-6-20	1000	110	60	200
34-0-0	100	34	0	0
27-0-0	100	27	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, a less costly fertilizer program can be obtained.

Transplant Starter Solutions

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

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

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

Measurement of plants in the field indicated that Trts. 3-6 (high P) resulted in more rapid early season growth than observed with the low P fertilizer (Trt. 2) or untreated plants (Trt 1). As plants neared topping stage, differences between the treatments tended to diminish. However, plants in Trts 3-6 did come into top earlier than those in Trts 1 and 2. There was no apparent difference in the response of plant bed and greenhouse-grown transplants to the fertilizers. Research conducted previously has shown the benefit of available P on early season growth; however, no benefit has been observed in the final yield of the crop. Such was the case with this study also. There was no significant difference in the yield of any of the treatments for both plant bed and greenhouse transplants, regardless of early-season growth effects observed (see Table4).

Table 4. Topping and yield data for six transplant water treatments applied to plant bed and greenhouse float transplants, Southern Piedmont AREC, 1993.

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

GH = greenhouse and PB = plant bed grown transplants

Liming

A liming program, based on a soil test, should be a part of the overall management program for burley tobacco production. According to a summary of soil analyses from the Virginia Tech Soil Testing Laboratory, approximately 31% of the tobacco fields in Virginia need liming. With the shift to higher analysis fertilizer grades containing less lime filler, there is a greater need to supply calcium and magnesium through a liming program. Calcium and magnesium can be obtained at a lower cost from lime than from fertilizers.

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

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

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

Lime 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

In acid soils there is an increase in the availability of manganese. This element, though essential for plant growth, may be taken up in sufficient amounts to be toxic to the plants. There usually is no trouble with manganese toxicity when the acidity level is pH 5.5 or higher, but it can be expected to occur if the soil reaction drops to pH 5.2 or lower.

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

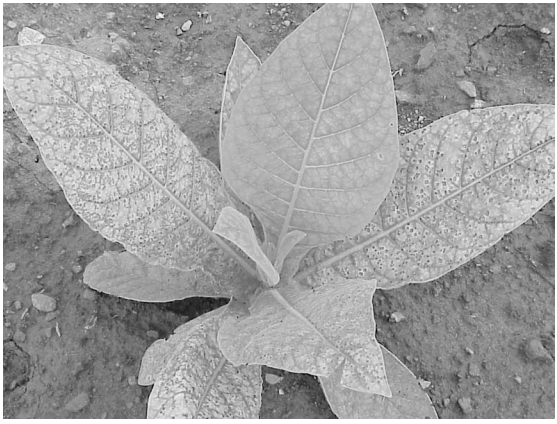

Figure1. Manganese toxicity in burley tobacco

Secondary Elements and Micronutrients

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

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

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

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

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

Method of Application

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

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

Foliar Fertilization

Using water-soluble fertilizers as a foliar application has not been proven to increase yields. Research from the University of Kentucky and more recent research at Virginia Tech has shown no advantage other than greening the crop up.

TOPPING AND SUCKER CONTROL

Topping

Research has shown burley tobacco to benefit from early topping, before the development of the full flower stage. Generally growers 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.

Figure 2. Burley tobacco plant at the early bloom stage of growth

Chemical Sucker Control

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

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

2. Systemic chemicals or maleic hydrazide (MH) restrict sucker growth physiologically by stopping cell division. The only growth made after MH is applied is in the expansion of cells already present in the plant. Maleic hydrazide should be applied as a course spray to the upper 1/3 of the plant. MH should be applied in a total spray volume of 50 gal/acre.

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

SUGGESTED TOPPING AND SUCKER CONTROL PROGRAMS

The following topping and sucker control programs may be followed:

Program I. Early Topping with Contact and Systemic Chemicals

1. Apply a contact sucker at a 4% concentration (2 gal. in 48 gal. of water or 5 oz. in 1 gal. of water) when plants reach the button stage.
2. A labeled rate of MH should be applied one week later. Alternatives to MH alone include:
    - A tank mix of Prime+, Butralin or other DNA at 2 qts/A with 1.5 gal./A or 2.25 lbs active ingredient of MH or 4 fluid ounces of Prime+, Butralin, or Drexalin Plus and 16 fluid ounces of MH in 3 gal of water.
    - FST-7 alone at 3 gal/A or tank mixed with Prime+ or Butralin (FST-7 is a commercial product combining MH with contact fatty alcohol).

Program II. Topping when crop reaches 50 percent bloom

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+, Butralin or Drexalin Plus at 2 qts/A with 1.5 gal./A of or 2.25 lbs active ingredient of MH
- FST-7 alone at 3 gal/A or tank mixed with Prime+ (FST-7 is a commercial product combining MH with contact fatty alcohol).

Program III. Prime+/Butralin/Drexalin Plus Individual Plant Method

Apply Prime+ with a dropline, backpack, or jug when plants reach the elongated bud stage. Usually two or three trips are required to remove tops and treat all plants in the field. Individual plants should not be treated more than once. **Growers are reminded to comply with all label directions regarding worker protection standards (WPS).**

Precautions with contacts:

1. Apply when suckers are small (not over one inch long).
2. Never spray foam from tank; this will burn plants.
3. Do not spray extremely succulent tobacco (tobacco with a light green to creamy white bud area). This indicates a fast rate of growth.
4. Rain within an hour after application of contacts may reduce their effectiveness.

5. Avoid weak solutions of product (see Table 5). Contact solutions should be at least 4% concentration in order to kill both primary and secondary suckers.

Precautions with local systemics:

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

Precautions with systemics:

1. Do not apply during the hot part of the day when stomata are closed and leaves are wilted.
2. Rain within six hours after application of MH may reduce its effectiveness. Recent research by Seltmann in North Carolina showed that if a significant rain occurs more than three hours after application, only a half rate of MH should be reapplied to maintain good sucker control.

Butralin

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

EPA WORKER PROTECTION STANDARDS

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

ATTENTION!

Precautions

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

Suggestions for Application of Sucker Control Materials

Type of Product	When to Apply	Time of Day	Application Rate	Application Procedure
Contacts (fatty alcohols)	1. 1st appl. at 50% button 2. Later applications should be made 1 wk apart (if needed)	When plants are turgid and leaves dry (mid-morning to mid-afternoon)	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)
Local Systemics Prime+ , Butralin. or Drexalin Plus	1. Individual plants at elongated button stage (droplines or jug application) 2. 7-10 days after 1st contact application	When leaves are dry	2% solution or 1 gal in 49 gal of water (2.5 fl oz of Prime+ per gal of water)	coarse spray (20 psi and TG-3 or 5 nozzle) or drench using jugs and apply 1/2 fl oz per plant.
Systemics (MH)	When used as part of sequential control program - apply 7 to 10 days after last contact application.	In morning, after leaf surfaces are dry. Do not apply during the middle of hot days (plants wilted).	1 1/8 to 2 1/4 lb of MH (3/4 to 1 1/2 gal of 1.5 lb/gal product) (1/2 to 1 gal of 2.25 lb/gal product) Apply 40 to 50 gal of spray material per acre	40 to 60 psi using 3 hollow cone nozzles per row (i.e. TX-18) Direct spray toward upper third of the plant.

GREENHOUSE TRANSPLANT PRODUCTION

Danny R. Peek, Extension Specialist, Burley Tobacco
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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 incidence 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 1). 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 may not result in a useable transplant. Based on extensive research at Virginia Tech about 33 percent of spiral roots result in a useable transplant.

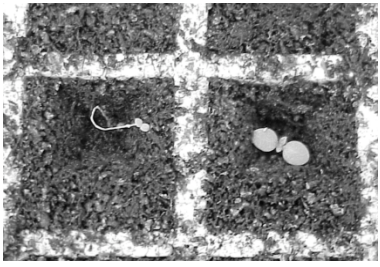

Figure 1: example of spiral root seedling and normal seedling

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 fling and not over packing media in trays. Differences may occur between different brands of media, but these incidences usually result from quality

control problems associated with specific batches of media rather than a consistent problem with a specific brand.

Recent research suggest a combination of factors are responsible for spiral rooting seedlings. These factors include seed pellet, variety, soilless media, and environment. Research has shown the seed pellet to be 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 for most growers because the seeding process can be significantly slower and it's very difficult to determine if there is a seed or multiple seeds in each cell of the tray. Tests have also shown differences between seed company's pelleting processes. Other factors such as growing media and environmental condtions 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 between burley varieties and the incidence of spiral rooting. For example KY14xL8 has proven to result in higher spiral root seedling than most other varieties. As described above, much of the causes of spiral root seedling may be largely out of the hands of the grower. Growers cannot alter the properties of the seed and or pellet. Growers should not try to alter the properties of a growing media but rather avoid using a media that is either too dry or too wet. Growers should be mindful of the environmental conditions of their greenhouse. A thermometer, placed at tray level, should be used as an indicator of temperature and not the thermostat controls. Optimum temperature is 65 - 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 more consistent environment around the seed pellet. Research conducted at Virginia Tech and NCSU has shown that covering with growing medium and vermiculite is very effective in reducing the incident 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.

At the present time, covering tobacco seed is not recommended as a standard practice. However, growers that have significant problems with spiral root seedlings may want to cover a few trays to evaluate this practice for their operation. Since covering seed could delay seedling emergence by 1-3 days growers should delay fertilization 1-3 days after seeding to reduce the chance of salts injury. Additionally, growers should contact their local extension agent information on covering seed.

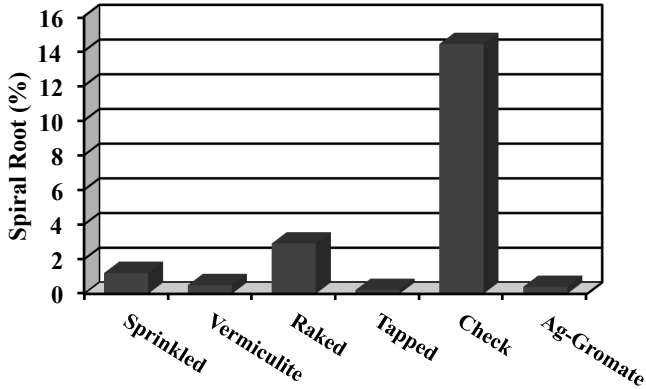

Figure 2: Effects of covering seeds from burley variety TN 90 with different materials and methods on the incident of spiral root seedlings

GREENHOUSE MANAGEMENT PRACTICES

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

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

2. Ventilation and Air Circulation
   Ventilation is necessary to remove moisture that naturally accumulates inside the greenhouse and to prevent high temperatures. Air circulation

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

3. Temperature Control

Greenhouses used for tobacco transplant production are difficult to precisely control the temperature. It's more difficult to keep temperatures cool than it is to keep them 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 65-70^{o}F. However, preliminary research shows we can reduce temperature to 60^{o}F at night and allow the temperature to increase to 80^{o}F during the day and still reach 95% germination in twelve days. Extended periods of cooler temperatures will delay germination. After germination, the minimum temperature may be reduced to 55^{o}F. Preventing high temperatures is more important than preventing low temperatures in a greenhouse. Young seedlings are particularly sensitive to high temperature, thus the temperature should be kept below 95^{o}F during the 2- to 4-leaf stage. Non-uniform seedlings and poor stand counts are more likely a result of excessively high than low temperatures. 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 100^{o}F. High temperatures place greater stress on the tobacco seedlings due to increased water usage and concentration of fertilizer salts within the growing medium. Growers should be aware that more transplants are lost due to excessively high temperatures as compared to low temperatures.

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

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

4. Media And Tray Filling

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

5. Fertilization

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

6. Water Quality

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

7. Clipping

Clipping is an essential management practice for direct-seeded greenhouse tobacco production. Begin clipping when plants are at least 2 to 2.5 inches to the bud. If seedling growth is unusually uneven, earlier clipping will allow smaller plants to catch up. Research conducted in Virginia indicates that the timing of the first clipping, the severity of clipping, and the number of total clippings does not have a significant impact on the stem diameter of the transplants. However, the above factors were important in controlling the growth rate of the seedlings and the size of the field-ready transplant. Very early clipping (1.5 inches to bud or less) resulted in shorter than desired transplants. Growers should be able to produce good uniform transplants by clipping three to five times. Higher number of clippings indicate the greenhouse was seeded too early. Seeding earlier than necessary will increase heating cost and increase 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 4-day interval between the first two clipping dates and every 5 to 7 days thereafter

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

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

Float Fertilization Programs

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

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

Under normal circumstances no additional fertilizer should be necessary beyond the total of 200 ppm N. However, if the greenhouse is seeded too early and the production season is extended or if transplanting is delayed, a late season addition of fertilizer (50 ppm N) may be necessary to maintain adequate seedling nutrient levels.

Program I is the preferred fertilization schedule. This program delays fertilization until trays have wicked and this helps to minimize fertilizer salts injury to young seedlings. Thus, 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 twenty-one days after seeding. Recently germinated seedlings need low levels of nutrients and most commercially available tobacco mixes will provide these nutrients. 75 ppm is adequate for burley transplants for the first 4 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 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.

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

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

Calculation of Water Volume and Fertilizer Concentration

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

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

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

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

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

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

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

Fertilizer analysis	ounces of fertilizer per 100 gals of water at various nitrogen (N) concentrations (ppm)					
	50	75	100	125	150	200
20-10-20 **or** 20-9-20	3.3	5.0	6.7	8.3	10.0	13.3
17-5-24	3.9	5.9	7.8	9.8	11.7	15.6
17-5-24 **and** 15-0-15[a]	2.6 **and** 1.5	3.9 **and** 2.2	5.2 **and** 2.9	6.6 **and** 3.7	7.8 **and** 4.4	10.5 **and** 5.9
16-4-16 **or** 16-5-16	4.2	6.2	8.3	10.4	12.5	16.6
15-5-15 **or** 15-4-15	4.3	6.7	8.9	11.1	13.3	17.7

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

Proper Tray Filling and Seeding are essential to produce a high percentage of usable plants. The media used for float transplant production is a specially formulated material and cannot be satisfactory substituted with common potting media used with house plants. Greenhouse tobacco mixes should be available from most farm supply dealers. When filling trays, media should have sufficient moisture to prevent media 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, thus, the cells don't wick uniformly or don't wick at all.

When filling trays by hand, distribute the media 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 seedlings. This condition occurs when the root of a germinating seed does not penetrate into the media. Extensive research has shown that approximately seventy percent of spiral root seedlings will not develop into a useable transplant (Figure 3). The cause of spiral root plants is not completely understood; however, it does appear to be related to inadequate media aeration (too little

air/too much water). Media must not be packed too tightly into trays or excessively moistened. If float trays are watered over-the-top to help dissolve seed coatings, water should be applied as a fine mist. Large droplets can result in excessive packing and waterlogging of the media.

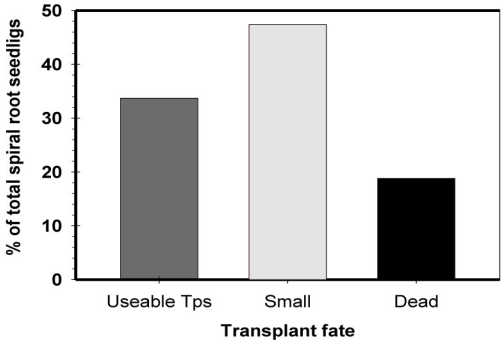

Figure 3. Fate of spiral root seedlings

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 producers selling transplants and plan to purchase new trays annually to reduce disease pressure.

A relatively new tray on the market is the "glazed tray". This is a process where the manufacturer seals the inner surface of the cells. The tray is reduced in height by approximately 0.5", 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, however, it is more expensive.

A tray, now commonly used by growers is a "shallow tray". This tray is the same length and width, and cell number as a regular tray. However, the tray is only 1.5" deep compared to 2.5" deep for the normal tray. The only real advantage to the shallow tray is the need for less soil-less media. Research shows little difference in seed germination and seedling growth.

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; and therefore, greater clipping frequency will be required to ensure adequate

stem size. In addition, the increased crowding of the seedlings necessitates more critical ventilation and moisture reduction within the greenhouse to prevent environmental conditions that favor the development of disease.

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

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

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

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

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

Tobacco Transplant Production in Outdoor Float Beds

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

Transfer beds are used only to grow plants off from a small seedling stage to transplant size. Seeds are not actually germinated in the outdoor transfer float bed. As a result, the heating requirement is greatly reduced since frost protection is the primary concern. The disadvantage of transfer beds is the increased labor necessary for hand transfer of the small seedlings to the float trays. The plug-and-transfer method was the original method of producing burley transplants using the float system. Commercially-grown "miniplugs" or small seedlings are purchased in special trays and transferred by hand to conventional float trays. Seedlings are grown to transplant size in either an outdoor float bed or greenhouse. Although miniplugs represent an additional expense, they do reduce the risk and management associated with other float transplant production methods. In the seed-and-transfer method seedlings are started from conventional, uncoated seed and transferred to float trays in outdoor beds. Detailed directions for seed-and-transfer tobacco transplant production may be found later in this section of the production guide.

Float Bed Construction

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

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

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

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

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

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

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

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

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

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

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

The bed frame should be lined with a single layer of 6 mil black plastic to hold water in the float bay. The ground under the plastic should be

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

Suggested Sizes of Outdoor Float Beds

The following are suggested dimensions for the style of float beds evaluated at the Southwest Virginia and Southern Piedmont ARECs. These beds consisted of a 2 x 6 frame for the water bed and a 2 x 4 frame (turned up on the 2 in. side) around the water bed to attach cover support bows made from 3/4 in. flexible water pipe. The 2 x 4 cover frame can be completely removed from the float bed to provide ventilation and allow for clipping.

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

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

Bows supporting the cover can be made from 1/2 or 3/4 in. plastic PVC pipe. Space bows 18 to 24 in. apart. The length of the bows should be 90 in. for a float bed 4 trays wide and approximately 104 in. for a bed 5 trays wide.

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

Heating of Outdoor Float Beds

Supplemental heat will be necessary for reliable production of transplants in outdoor float beds. Transfer beds may require limited heating for frost protection. Heat lamps strung above the plants for the length of the float bay (100 watts per 100 sq. ft.) or water bed heaters should provide adequate frost protection. Direct-seeded beds require more extensive heating to obtain satisfactory germination. The low cost, temporary nature of outdoor float beds limits the available options for heating. Early research with outdoor float beds evaluated the use of ceramic heaters for direct-seeded outdoor float beds. However, the use of such heaters is discouraged due to the potential electrical hazard associated with outdoor float beds. The high electrical demand of ceramic heaters coupled with safety considerations limit their usefulness in heating outdoor float beds. Each ceramic heater requires a separate 20 amp circuit with a ground fault interrupt.

Water bed heaters (heat mat placed under the bed liner) have successfully been used for heating direct-seeded float beds. One heater per 20 trays should be sufficient if other necessary procedures are followed. Thermostats should be set at 80^{o}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 Black plastic to reduce radiational heat loss occurring at night. Such covers should be provided when low temperatures are predicted to fall to 35^{o}F or below.

Growers must exercise extreme caution and follow all safety rules pertaining to electrical wiring and the use of electrical equipment in the outdoor environment and near water.

Covers for Outdoor Float Beds

Clear, solid plastic should not be used as a cover material for outdoor float beds. High temperatures may buildup very rapidly under solid plastic and kill young seedlings. The typical outdoor float bed does not have sufficient ventilation to prevent the buildup of excessive heat. Fabric plant bed covers, such as Reemay and Typar, are better suited for float beds. Although not essential, two layers of Reemay or a heavier weight cotton cover may be used to further insulate the beds during cold weather, particularly during germination of the seed. Vispore, a plant bed cover material made by Tredegar Industries, is a perforated plastic cover that has been evaluated on outdoor float beds at the Southwest Virginia and Southern Piedmont ARECs. The very small holes in this material reduce the buildup of excessive heat, but are so small that rainfall cannot pass

through the cover onto the plants. It is recommended that the heavier grade (2.5 mil) of this cover be used for float beds, and that the cover should be turned with the rough side up (to better shed water).

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

An on-farm study showed fewer incidences of spiral root seedlings when produced using the 50% shade plastic with the outdoor float bed than in a traditional greenhouse. This 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 in burley results from accurate diagnosis of disease problems, careful consideration of disease severity in each field, and prudent use of disease control practices. *Consistent disease control depends on the use of several control practices together. Crop rotation, early root destruction, and resistant varieties should always be used in conjunction with disease control chemicals.*

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

DISEASE-RESISTANT VARIETIES may be the most cost-effective way to control disease, but significant losses can still occur. Roots and tobacco debris should be plowed-out and destroyed as soon as possible after harvest.

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

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

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

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

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

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

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

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

Table 2. Steps in Early Root Destruction

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

DISEASE CONTROL IN TOBACCO GREENHOUSES

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

Disease causing organisms can enter a greenhouse in soil or plant debris, so entrances should be covered with asphalt, concrete, gravel, or rock dust.

Footwear should be cleaned or disinfected before entering a greenhouse. Float bays should be re-lined with fresh plastic each year and should be free of soil and plant debris.

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

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

Condensation in the greenhouse favors disease. Temporarily lowering the side-curtains near dusk and ventilating the greenhouse with horizontal airflow fans will help reduce condensation. Minimize practices that potentially splash medium from one tray cell to another. Correcting drainage problems in and around the greenhouse will also help avoid excess humidity.

To avoid spreading diseases like bacterial soft rot (black leg), 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. High vacuum mowers should be used to clip tobacco seedlings. Clippings, unused plants, and used media should be dumped at least 100 yards from the greenhouse.

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

SPECIFIC DISEASES IMPORTANT IN VIRGINIA

Black Shank – is caused by a fungus-like pathogen that lives in soil and attacks tobacco roots and stalks. Disease losses can usually 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. In addition, using a soil fungicide can't 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.* Selection of rotation crops is very important. Legumes such as red clover, vetch, and soybeans are as susceptible to root-knot and lesion nematodes as tobacco. NC 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:

Obtaining transplants locally will reduce the chances of introducing blue mold from tobacco production areas outside Virginia. Application of blue mold fungicides should begin as soon as 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. Forum tank-mixed with Dithane, Manzate, or Penncozeb, or Quadris, or 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

Hollow cone type nozzles should be used to ensure thorough coverage of all leaves. Air blast sprayers can be used for small plantings. Fungicides should be mixed at twice the normal concentration when an air blast sprayer is used. However, spray volumes should be cut in half when using an air blast sprayer.

Complete coverage is not required when Actigard is used for blue mold control. However, tobacco plants need 4-5 days after application of

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

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

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 5-7 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 20-100 gallons per acre to maximize coverage as plants increase in size. Spray pressures should generally range between 40-100 psi. Use of drop nozzles will significantly improve disease control after layby by improving spray coverage on bottom leaves, where foliar diseases are usually concentrated.

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

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

DISEASE RESISTANCE LEVELS OF SELECTED BURLEY VARIETIES[1]

	Black Shank				Black		Tobacco				Aphid
	Rating for Race 0		Rating for Race 1		Root	Fusarium	Mosaic		Brown	Blue	Transmitted
Variety	Verbal	KY/TN [2]	Verbal	KY/TN [2]	Rot	Wilt	Virus	Wildfire	Spot	Mold	Viruses
KT 209 LC	H	10	MH	8	H	S	H	H	--	S	H.M[4]
KT 210 LC	H	10	M	7	H	M	H	H	--	S	S
KT 206 LC	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
HB 3307P LC	H	10	L	3	H	--	S	--	--	S	H/M[4]
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]
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	L[5]	H	H	--	0	S
NC BH-129	S	1	S	1	H	S	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; -- = no information available.

[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.

Table 3. DISEASES OF TOBACCO SEEDLINGS

Disease	Material	Rate
Angular Leaf Spot or Wildfire *(Pseudomonas)*	Agri-mycin 17, Firewall, Fire-wall 17WP, etc	100-200 ppm (2-4 tsp/3gal)
Remarks: Foliar Spray: 100 ppm = 4 oz/50 gal or ½ lb/100 gal; preventative use. 200 ppm = ½ lb/50 gal or 1 lb/ 100 gal; curative use.		
Anthracnose *(Colletotrichum gloeosporoides)*	Dithane DF Rainshield	0.5 lb/100 gal (1 level tsp/gal)
Blue Mold *(Peronospora tabacina)*; **Target Spot** *(Thanatephorus cucumeris)*	Manzate ProStick Penncozeb 75DF	
Remarks: Apply as a fine foliar spray to the point of run-off to ensure thorough coverage. Begin applications before disease has been observed, but not before seedlings are the size of a dime. Use 3 gal of spray mixture /1000 sq. ft. when plants are about the size of a dime. Use 6 gal /1000 sq. ft. when the canopy has closed and plants are close to ready for transplanting. Repeat applications on a 5-7 day interval to protect new growth.		
Blue mold *(Peronospora tabacina)*	Aliette	0.5 lb/50 gal
Remarks: Foliar spray; apply no more than 0.6 lb/1,000 sq.ft; CAN BURN PLANTS IF WASHED INTO MEDIA OR FLOAT WATER; no more than 2 sprays/greenhouse season.		
Pythium Root Rot (*Pythium* spp.)	Terramaster 35WP	2 oz/100 gal of float bed water
	Terramaster 4EC	Preventative: 1 fl oz/100 gal Sequential: 1 fl oz/100 gal Curative: 1.4 fl oz/100 gal 2nd Curative: 1-1.4 fl oz/100 gal.
Remarks: Can be used before or after symptoms appear, but no earlier than 2 weeks after seeding. If symptoms reappear, a second application can be made no later than 8 weeks after seeding. No more than 2.8 fl.oz./100 gallons of water may be applied to any crop of transplants, regardless of the number of applications. **MUST BE EVENLY DISTRIBUTED**. When mixing, *first form dilute emulsion*, then distribute diluted emulsion evenly and thoroughly in float bed water.		
Tomato Spotted Wilt Virus (TSWV)	Actigard 50WG	1-2 oz/100,000 plants (~350- 288-cell trays)
Remarks: *Must submit liability waiver to receive a copy of the label, which is required for use.* One foliar application in the greenhouse 5-7 days prior to transplanting in sufficient water to ensure good coverage (~6 gal/1,000 sq. ft.); **use of accurate rate is critical to avoid crop injury.** In general, a 10-15% stand loss due to TSWV should be expected before considering application of Actigard to tobacco seedlings. Use of systemic insecticides such as imidacloprid or thiamethoxam as well as Actigard will significantly improve control of TSWV. Tank-mixtures are not recommended, but product may be left on foliage or washed off into the root ball.		

FIELD DISEASES OF TOBACCO

Root and Stem Diseases

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

[1] Preplant – broadcast, preplant incorporated spray; 1st cultivation – broadcast spray just before 1st cultivation ; layby - broadcast spray just before layby; F-Row – inject 8 inches deep in row with single shank in center of row. Do not use more than a total of 3 qt of Ultra Flourish or 3 pt of Ridomil Gold per acre.

[2] Control rating - F=fair; G=good; VG=very good. (-) - No disease control or not labeled for this disease.

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

FIELD DISEASES OF TOBACCO (Cont'd)

Foliar Diseases

Disease	Material	Rate[1]	Application Method[2]
Blue mold *Peronospora tabacina*);**Tomato Spotted Wilt Virus** (TSWV)	Actigard 50WP	0.5 oz/20 gal/A	Foliar
Remarks: Begin applications when blue mold disease threatens and plants are 12 inches tall. Up to 3 sprays may be applied on a 10-day schedule. Treated plants require 3-5 days to fully respond to each application. TSWV sprays beginning within 7 days of transplanting or whenever plants have recovered from transplant shock may also be used to follow-up on greenhouse application of Actigard for TSWV control.			
Blue mold *Peronospora tabacina*)	Aliette	2.5-4.0 lb/A	Foliar
Remarks: No more than 5 sprays allowed, 3 day pre-harvest interval; don't tankmix.			
Blue mold *Peronospora tabacina*)	Ridomil Gold EC MetaStar 2E AG Ultra Flourish	0.5-1 pt + 0.5 pt/A 2-4 pt + 2pt 1-2 pt + 1 pt/A	Preplant + Layby
Remarks: Strains of the blue mold pathogen are often insensitive to mefenoxam, but mefenoxam may control sensitive strains early in the season, as well as *Pythium* damping-off. Read precautionary and rotation crop restrictions.			
Blue mold *Peronospora tabacina*)	Acrobat 50WP + Dithane DF Rainshield, Manzate ProStick, or Penncozeb 75 DF	7.0 oz/100 gal water + 2.0 lb/100 gal water	Foliar Spray
	Forum + Dithane DF Rainshield Manzate ProStick, or Penncozeb 75 DF	7.0 fl oz/100 gal water + 2.0 lb/100 gal water	
Remarks: Begin sprays when the Blue Mold Advisory predicts conditions favorable for disease. Continue applications on a 5-7 day interval until the threat of disease subsides. Apply 20 to 30 gal/A of spray solution during the first several weeks after transplanting and gradually increase spray volume as the crop grows. Spray volumes should reach 40 gal/A by layby and should range between 80 and 100 gal/A on tobacco ready to be topped. Do not exceed 2.5 lb/A of Acrobat per application or 10 lb/A per season. Do not apply after the early button stage or within 21 days of the first harvest.			

FIELD DISEASES OF TOBACCO (Cont'd)

Foliar Diseases

Disease	Material	Rate[1]	Application Method[2]
Blue mold (*Peronospora tabacina*); Frogeye (*Cercospora nicotianae*); **Target Spot** (*Thanatephorus cucumeris*)	Quadris	6-12 fl. oz.	Foliar Spray

Remarks: First application for blue mold should be made at first indication of disease in the area; for target spot, spray at or soon after layby; don't spray Quadris "back-to-back" for blue mold, but alternate with another fungicide; spray sufficient water volume for complete coverage and canopy penetration; may enhance weather flecking, but this shouldn't affect yield or quality; up to 4 applications/year allowed; may be applied up to the day of harvest; tankmixing with insecticides formulated as ECs or containing high amounts of solvents may cause some crop injury.

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

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

DISEASES OF TOBACCO

There Are No Chemical Controls For the Following Diseases

Disease	Remarks
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. Reducing surface moisture on leaves and stems by correct watering and improved ventilation, and collecting and removing loose-leaf material from clipping, will help reduce damage.
Brown Spot (*Alternaria alternata*)	Can be severe on mature tobacco, especially during periods of high humidity. Good sucker control also helps reduce disease incidence.
Collar Rot (*Sclerotinia sclerotiorum*)	Symptoms resemble damping-off. Small groups of plants have brown, wet lesions near the base of stems. Leaf rot may appear to progress from leaf margins or tips toward the stem. White, cottony, mold may be visible. Irregularly shaped, white to black objects (sclerotia) may also be found attached to severely infected plant parts. Infected plants, as well as plants immediately adjacent to diseased areas, should be discarded as soon as possible. Improving ventilation and reducing excess moisture may help reduce spread. 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 thunderstorms and/or air pollution. 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 appropriate use of herbicides. Application of a herbicide before transplanting (PRE, PPI) or over-the-top at transplanting (OT) will reduce reliance on tillage and cultivation for early season weed control. Some herbicides may also be applied to the row middle just after the last cultivation to obtain full season weed control. Herbicide use should be based upon the specific weeds present in each field, the weed control program that integrates best with overall farm management practices, herbicide cost in relation to performance and crop safety, and anticipated rotational crops. Herbicide performance and safety are dependent upon the use of correct application methods. Special effort should be made to apply all herbicides exactly as stated on the product label.

IMPORTANT CONSIDERATIONS IN HERBICIDE USE

Selecting the Proper Herbicide

Weed Identification - Identifying the problem weeds in each field should be the first step in any weed control program. Check herbicide labels to ensure that the products are active against the desired weeds. Using herbicides in rotation crops may reduce populations of hard-to-control weeds in tobacco fields. The table on page 68 is a relative summary of herbicide performance for the majority of weeds found in burley tobacco fields in Virginia.

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

Proper Herbicide Application

Soil Preparation – All weed growth and crop stubble should be thoroughly worked into the soil prior to application of most tobacco herbicides. Soil should be moist and loose, with all clods broken up, before a herbicide is applied.

Spray Equipment - A standard low-pressure (25 to 50 psi) boom sprayer should be used to apply herbicides. Use in 20 to 40 gallons of water per

acre. Check for clogged nozzles and screens frequently while spraying. Use 50-mesh screens in strainers, nozzles, and suction units. Clean or replace dirty or worn out sprayer, boom, and nozzle parts to ensure uniform application. Be sure to calibrate the sprayer before use to avoid crop injury and/or poor herbicide performance from improper spray volume or a non-uniform spray pattern. Ensure that the spray solution is continuously agitated. Do not apply a herbicide in strong wind, since wind can cause uneven coverage and potential spray drift damage to surrounding areas. Poast should be applied at 5 to 20 gallons of water per acre. Never leave a spray mixture in a sprayer overnight!

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

Undesired Effects of Herbicide Use

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

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

BURLEY TOBACCO HERBICIDES

Preplant Herbicides (PRE, PPI) Apply the herbicide in an even broadcast application. Avoid spray overlap! Use even, fan-type, flood-jet, or raindrop nozzles. Formulations of Spartan and Command are designed for surface application before transplanting and do not require incorporation. Apply these to the soil surface at least 12 hours before transplanting. Prowl and Devrinol require incorporation (PPI). Preplant tobacco herbicides should be incorporated no deeper than 2 inches.

Spartan Charge contains the same active ingredient (sulfentrazone) as Spartan 4F, but also contains carfentrazone, the active ingredient in Aim. Spartan Charge may be surface-applied or incorporated before transplanting, but not afterwards. *Tobacco leaves will burn if contacted by sprays containing Spartan Charge.* The following table presents rates of Spartan Charge, Spartan 4F, and Aim that deliver equivalent amounts of active ingredient:

SPARTAN CHARGE CONVERSION TABLE

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

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

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

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

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

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

An OT application of Command 3ME can be made as either a band or broadcast application within 7 days of transplanting. An OT application of Devrinol 50DF can also be made immediately after transplanting. Devrinol should be shallowly incorporated, or irrigated in, if rainfall doesn't occur within 5 days of application.

1. Band Application - Apply the herbicide in a 14 to 24 inch band over the row using fan-type, even-spray nozzles (8004E, etc.). The amount of herbicide per acre of crop is reduced with band application and can be determined by the following formula:

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

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

Apply layby herbicides as directed sprays to row middles immediately after the last normal cultivation. Use drops equipped with flat, flood-jet (TK2, TK4, etc.) or even, flat-fan (8004, etc.) nozzles to apply the herbicide solution in a 16 to 30 inch band in the row middles. Use nozzles which apply one-half (½) the normal number of gallons per acre where spray nozzles on the end of the boom pass over the same row middle twice (to prevent over-application). Use the formula above to determine the amount of product to use for a band application. Irrigation will be required if 0.5 to 1 inch of rain does not fall within 7 to 10 days after application (to ensure herbicide activation).

RELATIVE EFFECTIVENESS OF HERBICIDES FOR TOBACCO*

Grasses and Nutsedge

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

Broadleaf Weeds

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

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

WEED CONTROL IN BURLEY TOBACCO FIELDS

Weed Problems	Soil[1] Texture	Chemical Lbs Active Ingredient/A	Product per Acre	Applic.[2] Method
Pigweed, lambsquarters, nightshade, purslane, smartweed, velvetleaf, spurred anoda, carpetweed, cocklebur, cotton, groundcherry, morningglory, common ragweed		Carfentrazone 0.012-0.024 0.013-0.023	 Aim 0.5-1.0 oz. Aim EC or Aim EW 0.8-1.5 fl. oz.	Pretransplant burndown; shielded or hooded spray before layby; directed spray after 1st harvest
Remarks: ***Spray solution will cause extensive burn to broadleaf plants (and tobacco leaves) on contact.*** Pre-transplant interval = 1 day; pre-harvest interval = 6 days. Do not apply more than 2.0 oz. Aim or 3.0 fl oz. Aim EC or EW per care per season..				
Barnyardgrass, broadleaf signalgrass, crabgrass, field sandbur (suppression), foxtails, seedling Johnsongrass, fall panicum, velvetleaf, jimsonweed, lambsquarter, prickly sida, purslane, spurred anoda, venice mallow, common ragweed, smartweed, cocklebur (suppression), shattercane	 Coarse Fine	Clomazone 0.75 1.0	Command 3ME 2.0 pt 2.7 pt	OT
Remarks: Use the higher rate for heavy weed pressure or heavy soils. Transplants should be placed below the treated area. Do not use in plant beds. Stands of grass cover crops may be reduced if planted within 9 months of Command 3ME application. Do not graze or feed cover crops planted less than 9 months after Command 3ME application.				
Barnyardgrass, carpetweed, crabgrass, fall panicum, foxtails, goosegrass, johnsongrass from seed, lambsquarters, pigweed, common purslane, ragweed (suppression), ryegrass; check label for uncommon weeds.	 Coarse Medium Fine Coarse Medium Fine	napropamide 1.0 1.0-1.5 2.0 1.0 1.0-1.5 2.0	Devrinol DF 2.0 lb 2.0-3.0 lb 4.0 lb Devrinol 2E 2 qt 2-3 qt 4 qt	PPI, OT, Layby PPI only
Remarks: For PPI application, incorporate the same day as applied. Small grain injury may result from PPI application method.				

WEED CONTROL IN BURLEY TOBACCO FIELDS (continued)

Weed Problems	Soil[1] Texture	Chemical Lbs Active Ingredient/A	Product per Acre	Applic.[2] Method
Grass weeds and volunteer small grain	All types	sethoxydim	Poast	Postemergence
	Single use:	0.28	1.5 pt + 2 pt oil concentrate	
	Sequential use:	0.19	1 pt + 2 pt oil concentrate	
Remarks: Apply to actively growing grasses in 5-20 gal/A. May be banded or applied broadcast. Do not apply more than 4 pt/A per season or within 42 days of harvest.				
Annual spurge, barnyardgrass, carpetweed,		Pendime-thalin	Prowl 3.3 EC or Pendimax 3.3	
crabgrass,	Coarse	0.74-0.99	1.8 – 2.4pt	PPI only
crowfoot grass,	Medium	0.74-1.24	1.8 - 3.0 pt	
Florida pusley, foxtails,	Fine	0.99-1.24	2.4 - 3.0 pt	
goosegrass,	Coarse	0.50 – 0.74	1.2 – 1.8 pt	Layby only
johnsongrass	Medium	0.74 – 0.99	1.8 – 2.4 pt	
from seed, lambsquarters,	Fine	0.74 – 0.99	1.8 – 2.4 pt	
panicums,			Prowl H_20 3.8EC	
pigweed,	Coarse	0.95	2.0 pt	PPI only
purslane,	Medium	0.95 – 1.19	2.0 – 2.5 pt	
signalgrass.	Fine	1.19	2.5 pt	
	Coarse	0.71	1.5 pt	Layby only
	Medium	0.95	2.0 pt	
	Fine	0.95	2.0 pt	
Remarks: For silt and silt loam soils, use 2.4 – 3.0 pt/A of Prowl 3.3EC or 2.5 pt/A of Prowl H2O for PPI applications. *Rates are for broadcast application and must be adjusted for banded sprays based on the width of the intended spray band and soil texture.* Applied according to directions and under normal growing conditions, Prowl should not harm transplanted tobacco, but can temporarily retard growth under stressful conditions (cold/wet to hot/dry weather). Layby applications should be made as a directed spray in a 16 to 24 inch band centered between rows. Spray contacting tobacco leaves may cause deformations. Crop injury may result if winter wheat and winter barley are no-till planted in the fall after spring application of Prowl. Don't feed forage or graze livestock for 75 days after planting wheat or barley in Prowl-treated land.				

WEED CONTROL IN BURLEY TOBACCO FIELDS (continued)

Weed Problems	Soil[1] Texture	Chemical Lbs Active Ingredient/A	Product per Acre	Applic.[2] Method
Groundcherry, hairy galinsoga, jimsonweed, lambsquarters, morningglory (except pitted), nutsedge, pigweed, prickly sida, Pennsylvania smartweed. Suppresses most grasses, foxtail, panicums, cocklebur, signalgrass, spurges. Check label for uncommon weeds.		sulfentrazone	Spartan 4F	After bedding, before transplanting
	Coarse			
	<1.5%OM	0.14-0.19	4.5-6.0	
	1.5-3%OM	0.19-0.25	6.0-8.0	
	>3%OM	0.25-0.32	8.0-10.1	
	Medium			
	<1.5%OM	0.19-0.25	6.0-8.0	
	1.5-3%OM	0.25-0.32	8.0-10.1	
	>3%OM	0.32-0.38	10.1-12.0	
	Fine			
	<1.5%OM	0.25	8.0	
	1.5-3%OM	0.32	10.1	
	>3%OM	0.38	12.	

Remarks: %0M = % organic matter. Apply this product only as specified on the label. Do not apply to soils classified as sands with less than 1% 0.M. and shallow ground-water. *Most tobacco fields in Virginia contain coarse to medium textured soils.* Do not impregnate on fertilizer. Apply to soil surface after field has been prepared for planting. Apply within 14 days of transplanting, **after** beds are knocked down for planting. **Do not** apply at or after transplanting. Do not disturb treated soil below a 2 inch depth. *Crop injury can occur when incorporation is poor, transplants are set too shallow, or heavy rain falls near transplanting.* **Do not** apply Spartan more than once per season. Do not seed small grains within 4 months of application. Do not plant cotton or canola within 18 months of use.

WEED CONTROL IN BURLEY TOBACCO FIELDS (continued)

Weed Problems	Soil[1] Texture	Chemical Lbs Active Ingredient/A	Product per Acre	Applic.[2] Method
Hairy galinsoga, goosegrass, groundcherry, jimsonweed, lambsquarters, morning-glory, wild mustard, nightshade, nutsedge, orchardgrass, pigweed, prickly sida, broadleaf signalgrass, Pennsylvania smartweed.		sulfentrazone + carfentrazone	Spartan Charge	Burndown, preplant surface application, PPI
	Coarse			
	<1.5%OM	0.14 – 0.19 + 0.016 – 0.021	5.7 – 7.6	
	1.5-3%OM	0.19 – 0.25 + 0.021 – 0.028	7.6 – 10.2	
	>3%OM	0.25 – 0.32 + 0.028 – 0.035	10.2 – 12.8	
	Medium			
	<1.5%OM	0.19 – 0.25 + 0.021 – 0.028	7.6 – 10.2	
	1.5-3%OM	0.25 – 0.32 + 0.028 – 0.035	10.2 – 12.8	
	>3%OM	0.32 – 0.38 + 0.035 – 0.042	12.8 – 15.2	
	Fine			
	<1.5%OM	0.25 + 0.028	10.2	
	1.5-3%OM	0.32 + 0.035	12.8	
	>3%OM	0.38 + 0.042	15.2	

Remarks*:* May be surface applied or preplant incorporated (less than 2 inches) from 14 days to 12 hr before transplanting. Beds must be knocked down before applying the product. If no incorporation, timely cultivation after transplanting is required for acceptable weed control. Tobacco may be re-planted in treated soil, but DO NOT retreat or re-bed field. *Do not use in tobacco greenhouses.* May be tank-mixed with liquid fertilizer and other registered herbicides, but a jar test prior to mixing is recommended to ensure compatibility. See label for instructions. Do not apply to soils classified as sands with less than 1 percent organic matter. *Splashing of treated soil onto young tobacco may cause localized burning*. Do not apply more than once per site per season. Do not seed small grains within 4 months of application, or plant cotton within 18 months or canola within 24 months. See label for other crop rotational restrictions.

[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 ransplanting as a band or broadcast application. Layby = Application of herbicide in row middle after last cultivation. Preplant burndown = broadcast spray before transplanting in conservation tillage production system. Shielded or hooded spray = application to row-middles only using sprayer with shields or hoods to prevent spray contact to tobacco leaves. Directed spray = spray directed toward row-middles and surface of row-beds after sequential harvesting has removed sufficient leaves that spray will not contact remaining crop leaves.

PRECAUTIONARY AND RESTRICTION STATEMENTS

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

TOBACCO INSECT MANAGEMENT

Paul J. Semtner, Retired Extension Entomologist

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

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

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. **Early land preparation.** Plowing at least 4 weeks before transplanting reduces cutworm infestations and may aid in wireworm control.
2. **Adjustments in transplanting date.** This reduces tobacco susceptibility to insect pests. Early-planted tobacco is often less favorable for aphids and hornworms, and more favorable for budworms and flea beetles. Late-planted tobacco is highly susceptible to hornworm damage and may have reduced yield and quality. Aphid infestations are usually most serious on tobacco transplanted near the middle of the transplanting period.
3. **Destruction of greenhouse transplants as soon as practical after transplanting is completed.** This practice keeps aphids and other insects from developing high populations on the transplants and migrating to nearby tobacco fields.
4. **Management of field borders to reduce insect habitat**. Keep field margins clear of weeds and tall grass to reduce feeding, breeding, and over wintering sites for grasshoppers and other insects that move from these sites into tobacco fields. After tobacco is established and growing, leave uncut barriers between tobacco fields and hay fields that are heavily infested with grasshoppers.

5. **Topping tobacco in the button or early flower stage.** This practice eliminates food sources for budworms and makes the crop a less desirable host for aphids and hornworms.
6. **Obtaining effective sucker control.** Sucker control reduces food sources for hornworms, budworms, and aphids.
7. **Destroying crop residues immediately after harvest is completed.** Root destruction reduces feeding and overwintering sites for hornworms, budworms, and flea beetles. This practice is most effective when done on a community-wide basis.
8. **Use crop rotations that reduce infestations of soil-inhabiting insects.** Rotate tobacco with crops that are poor hosts of cutworms, white-fringed beetles, and wireworms. Beware of cutworm and wireworm infestations following established grass sods and soybeans.
9. **Conservation tillage.** Use conservation tillage practices to manage insect infestations. Conservation tillage strategies including no-till and strip-till reduce aphid and flea beetle populations, but may increase problems with cutworm, vegetable weevil, and slug infestations.

Natural Control

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

Hornworms are parasitized by the larvae of *Cotesia congregata*, which feeds inside the caterpillars. When these larvae mature, they emerge through the backs of the hornworms and form egg-like cocoons. Tiny wasps emerge from these cocoons in a few days, mate, and lay eggs in other hornworms. Stilt bugs are long-legged, slender, brown bugs that feed on hornworm and budworm eggs, aphids, and even small amounts of tobacco sap.

Aphids are attacked by the adults and larvae of several species of lady beetles, lacewings, and syrphid fly larvae. Bright red midge larvae also feed on aphids after topping. The pathogenic fungus, *Pandora neoaphids,* frequently controls aphids from July through September, especially in wet seasons. Although lady beetles, lacewings, and syrphid fly larvae are usually abundant on aphid-infested tobacco, they often have trouble keeping aphid populations below economic threshold levels.

To preserve beneficial insects, scout fields, and use economic thresholds to time insecticide applications. Select insecticides with low impact on beneficials. These insecticides include: *Bacillus thuringiensis (Bt)*, chloranthraniliprole (Coragen) emamectin benzoate (Denim), flubendiamide (Belt), methomyl (Lannate), pymetrozine (Fulfill), and spinosad (Tracer). Transplant water and tray drench applications of

imidacloprid (Admire Pro and various generics) and thiamethoxam (Platinum) have limited direct impact on beneficials.

Chemical control

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

Insect Control on Transplants Produced in the Greenhouse

Almost all of the tobacco transplants (>99%) used in Virginia is produced in greenhouses. So far, insects have caused minor problems in greenhouses. However, if recommended cultural practices are not carried out, several of the following pests could become serious problems.

- **Ants** can remove seeds from greenhouse trays and cause poor stands of seedlings.
- **Crickets and earwigs** often destroy newly emerged tobacco seedlings, reducing stands and initial growth.
- **Shoreflies**, tiny flies that look like small houseflies, are frequently numerous in greenhouses. Their larvae (tiny maggots) feed on young seedlings and may reduce stands during the first 2 weeks after germination.
- **Mice** remove the seeds from float trays seriously reducing plant stands. If stand loss is severe, the entire greenhouses may require reseeding.
- **Green June beetle grubs** uproot seedlings in the trays sitting on the soil surface in greenhouses with overhead watering systems.
- **Cutworms, crickets, vegetable weevils,** and **slugs** usually feed on stems and leaves at night. Cutworms also cut off and destroy plants.
- **Crickets**, **cutworms**, **slugs**, and **yellow-striped armyworms** may destroy individual leaves on larger seedlings; this damage appears to do little harm unless populations are very high.

- **Vegetable weevil** adults and larvae often feed on the leaves and stems destroying the buds of seedlings.
- **Aphids** often build up high populations on tobacco seedlings in the greenhouse reducing plant vigor, and they may be carried to the field on infested plants.

Cultural controls in the greenhouse

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

- Discard all unused plants and clean out the greenhouse immediately after transplanting has been completed.
- Keep the area in and around the greenhouse clean and free of weeds, decaying plant material, plastic, rocks, wood, metal, and other items that provide food and shelter for insects and other pests.
- Do not plant fall and winter gardens near the greenhouse. Aphids can survive on various vegetables and related weeds during the winter and develop winged forms that fly into greenhouse and establish colonies on tobacco seedlings. Pests such as cutworms, armyworms, vegetable weevils, and slugs may hide in these sites, migrate into the greenhouse, and damage tobacco seedlings.
- If greenhouses are used to produce other crops, a fallow period should be followed to keep pests from moving from the other crops. Whiteflies or aphids may become problems by moving from earlier crops to tobacco.
- Use extreme temperatures to kill insects hiding in the greenhouse. Close the greenhouse to increase the temperature in the summer and promote cold temperatures in the winter.
- Seed the entire greenhouse at the same time. Do not seed tobacco in greenhouses that are already infested with large numbers of shore flies. Shore flies lay eggs on the media and the larvae injure emerging seedlings reducing stand and seedling uniformity
- Clean the greenhouse thoroughly just before seeding in the spring.
- Produce a uniform crop.

Chemical control in the greenhouse

Acephate (Orthene or other generics) is the only effective insecticide labeled for use on tobacco transplants grown in greenhouses (Table 1). It

should be applied as a foliar spray when insect infestations are observed. Acephate provides good to excellent control of aphids, yellow-striped armyworms, cutworms, flea beetles, and vegetable weevils. It should not be applied in the irrigation water or the float water. Acephate also gives effective control of ants when applied in the greenhouse before the float beds are set up. When spraying young plants, use the proper rate. Excessive rates of acephate can injure or kill young seedlings.

Metaldehyde (Deadline Bullets) bait controls slugs and snails in the greenhouse. In the early evening, apply methaldehyde along walkways and the outside margins of the float beds. Do not apply methaldehyde directly to seedlings or use it in float beds.

Mice should be controlled with baits labeled for their control.

Table 1. Insecticides for use on Transplants Grown in Greenhouses

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	¾ tbs/3 gal of water (¾ lb/acre)
	(Orthene) 97PE	¾ tbs/3 gal of water (¾ lb/acre)
Remarks and precautions: Apply as a spray. **Excessive rates of acephate can injury tender young plants. Do not apply through an irrigation system or in the float water.**		
Snails and slugs	Metaldehyde (Deadline Bullets) 4% bait	¼ to ½ 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	¾ oz/5 gal of water
	(Orthene) 97PE	¾ 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. 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, white to yellowish-brown, wire-like larvae of click beetles. These pests live in the soil, feed on the roots, and tunnel the piths of young tobacco plants. This injury stunts plant growth, causing irregular stands and lower yields. Although wireworms feed throughout the growing season, the most serious damage occurs when the plants are becoming established during the first month after transplanting. Wireworms take 1 to 5 years to complete their life cycle. Most of this time is spent in the larval stage. The larvae emerge from eggs in the summer and fall, feed on the roots of various host plants, and overwinter into the next year. Larvae then feed on the newly transplanted tobacco seedlings. Pupation and emergence as adult click beetles occurs in late spring and early summer.

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

Cutworms

Cutworms are active at night, feeding on roots or leaves or cutting off entire plants. This injury can cause enough damage and stand loss to require replanting. However, since tobacco compensates well, less than five percent stand loss usually has no impact on yield but it may affect uniformity. Cutworm infestations are very sporadic and difficult to predict, but they are most likely to occur in low, wet areas, and weedy fields that are plowed less than a month before transplanting. Plowing fields in the early spring usually destroys the cover crop and weed hosts, and reduces cutworm populations. Scout fields for cutworm damage once or twice a week during the first month after transplanting to determine whether a remedial foliar treatment is needed (Table 10). For optimum control of this night-feeding pest, apply a foliar insecticide in late afternoon or early

evening when five percent or more of the plants in a field have recent cutworm damage.

Whitefringed beetles

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

Soil-incorporated insecticides

Pretransplant soil applications of insecticides can provide effective control of cutworms and wireworms on tobacco. Several factors should be considered before selecting a soil insecticide.

- If a tobacco field has been in sod, weeds, or small grains during the previous year or has a history of wireworm problems, apply an insecticide for wireworm control.
- Mocap, Brigade/Capture, and Lorsban are broadcast soil treatments for wireworm control (Tables 2 and 3).
- Admire Pro or Platinum applied as transplant water or transplant drench treatments may be better choices for wireworm control because they also control aphids and flea beetles (Tables 2, 4, and 5).
- Soil fumigants applied at the nematicide rate provide little control of insects in the soil or on the foliage because many insects are below the zone being fumigated.

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

Insecticide	Application method [1]	Leaf feeding insects			Soil insects		
		Aphids	Bud-worms	Flea beetles	Horn-worms	Cut-worms	Wire-worms
Acephate/Acephate AG/ Acephate UP; Orthene 97	TW	2	0	3	0	3-4	0
Imidacloprid (Admire Pro and generics) [2]	TW	5	0	2	0	0	3
Imidacloprid (Admire Pro and generics) [2]	TD	5	0	4	0	0	3
Bifenthrin (Brigade/ Capture and generics) [2]	TW PPI	0	0	0	0	3	3
Chlorpyrifos (Lorsban) 4E	PPI	0	0	1	0	3	4
Chlorantraniliprole (Coragen)	TPW	0	2-3	0	3	0	0
Lambda cyhalothrin (Karate, Warrior and others)	PPI	0	0	0	0	3	0
Ethoprop (Mocap) 6EC	PPI	0	0	1	0	3	4
Thiamethoxam (Platinum/TMOXX) 2F	TW	5	0	3	0	0	3
Thiamethoxam (Platinum/TMOXX) 2F	TD	5		4		0	3

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

[1] TW = Transplant water, TD = Transplant drench, PPI=Preplant soil incorporated.

[2] There are many generic formulations of imidacloprid and bifenthrin.

Table 3. Insects on Field Tobacco - Pretransplant Soil Treatments

Insect	Insecticide and formulation	Rate per acre
Wireworms, Cutworms	Ethoprop (Mocap) 6EC	1 1/3 to 4 qt
	(Mocap) 15G	13 lb
	Chlorpyrifos (Lorsban) 15G	13 ½ lb
	(Lorsban and generics) 4E	1 qt
	Lorsban Advance 3.755EW	1 qt
	Bifenthrin (Brigade/Capture and generics) 2EC	2.56 to 6.4 fl oz
	Lambda cyhalothrin (Karate with Zeon and generics)	1.92 fl oz

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

Table 4. Insects on Field Tobacco - Transplant Water Treatments

Insect	Insecticide and formulation	Rate
Flea beetles, cutworms, thrips, suppression of aphids	Acephate (Acephate AG) 75SP	1 lb/acre
	(Acephate) 97UP	0.75 lb/acre
	(Orthene) 97PE	0.75 lb/acre
	Bifenthrin (Brigade/Capture) 2EC	2.56 to 6.4 fl oz/acre
Aphids, flea beetles	Imidacloprid (Admire Pro) 4.6SC	0.5 to 0.6 fl oz/1,000 plants
	(various generics) 2F	1.0 fl oz/1,000 plants
	Thiamethoxam (Platinum/TMOXX) 2SC	0.5 to 0.8 fl oz/1,000 plants or 3 to 5 fl oz/acre
Budworms, hornworms	Chlorantraniliprole (Coragen) 1.67SC	5.0 to 7.5 fl oz/acre
Remarks and precautions: Apply in at least 100 gallons of water per acre. Coragen must be applied uniformly in the root zone or poor performance will result.		
Wireworms, thrips for suppression of tomato spotted wilt virus	Imidacloprid (Admire Pro) 4.6SC	0.8 to 1.2 fl oz/1,000 plants
	various generics) 2F	1.4 to 2.8 fl oz/1,000 plants
	Thiamethoxam (Platinum/TMOXX) 2SC	0.8 to 1.3 fl oz/1,000 plants or 5 to 8 fl oz/acre
Remarks and precautions: 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 give excellent season-long control of aphids. Apply treatments in at least 100 gal of water/acre. **Calibrate transplanters and allow tanks to run low before refilling.**		

Table 5. Insects on Field Tobacco-Drench Application to Greenhouse Transplants

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

Remarks and precautions: Apply as a drench to plants in trays 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 5 consecutive plants at 10 locations throughout the field. Select the plants before you see them. If a field is planted on two different dates or if there are great differences in plant size within the field, divide the field into two or more sections and sample each section separately. Large fields (more than 10 acres) will require larger samples. Sample an additional 10 plants for every 2 additional acres.
2. During the first 4 weeks after transplanting, check tobacco for feeding holes or missing, stunted, or cut plants. Cutworms, flea beetles, wireworms, and other insects may have damaged these plants.
3. Beginning 3 to 4 weeks after transplanting, aphids, budworms, flea beetles, and hornworms are the primary targets of an insect scouting program.

4. When a field is being scouted for insects that feed on tobacco foliage, individual plants should be examined and the observations recorded in a notebook as follows:

   a. Check the bud region for budworm damage. If damage is present, look carefully for budworms and the white cocoons of the budworm parasite, *Campoletis sonorensis.* If there is budworm damage, but no worm, do not count the plant as infested.

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

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

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

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

Table 6. Economic thresholds for various insects on tobacco.

Insect	Economic threshold	Time when insect is a problem (weeks after transplanting)
Aphids	50 or more aphids on any upper leaf of 5 of 50 plants.	4 weeks after transplanting to final harvest
Budworms	10 plants with one or more budworm per 50 plants until 1 week before topping.	3 weeks after transplanting to 1 week before topping
Cutworms	5 of 100 plants with recent cutworm damage.	1 to 4 weeks after transplanting
Flea beetles	4 beetles per plant on tobacco less than 2 weeks old, 8 to 10 beetles per plant on 2 to 4 week-old plants, 60 beetles per plant on plants more than 4 weeks old.	Transplanting to 4 weeks after transplanting and from topping to final harvest
Grasshoppers	10 grasshoppers per 50 plants.	4 weeks after transplanting to final harvest
Hornworms	5 larvae (worms) at least 1 inch long per 50 plants. Do not count parasitized worms with the egg-like cocoons on their backs. For hornworms ½ to ¾ inch long, treat when there is 1 hornworm per plant.	3 weeks after transplanting to final harvest. Can be a problem on air-cured tobacco in curing structures
Wireworms	Not determined	1 to 6 weeks after transplanting

Tobacco Budworms

Tobacco budworms feed in the buds of young tobacco plants causing many holes in the tiny developing leaves. As the leaves grow, the feeding holes become larger and give the plants a ragged, distorted appearance. Tobacco plants usually compensate for this damage so yield and quality may not be affected. However, budworms sometimes top the plants prematurely causing early sucker growth that may stunt the plants and require extra labor to remove the suckers. After the button stage, budworms rarely cause economic damage although they may burrow into the stalk. Apply foliar sprays for budworm control with 1 or 3 solid-cone or hollow-cone nozzles over each row using 40 to 60 psi to deliver 10 to 25 gallons of spray mixture per acre. Control with foliar sprays rarely exceeds 80%. The tobacco rows must be planted evenly so that the nozzles can be oriented directly over the row. See insecticide performance ratings in Table 7 and insecticide options for budworm control in Table 10. When checking tobacco for budworms, look on the leaves near the bud for the cocoons of

the wasp (*Campoletis*) that parasitizes budworms. These cocoons are about ¼ inch long and white or grayish in color with two black bands or dots. *Campoletis* and other parasites provide good natural control of budworms on tobacco in Virginia.

Hornworms

Tobacco and tomato hornworms are large caterpillars (up to 4 inches long) that eat considerable amounts of tobacco leaf. Infestations may develop anytime from transplanting until harvest, but damage is usually most severe during June, August, and September. Treat for hornworms when there are 5 or more hornworms 1 inch long or longer per 50 plants. Do not count parasitized hornworms that have the white egg-like cocoons of the parasitic wasp, *Cotesia congregata*, on their backs. Parasitized hornworms eat much less than healthy hornworms and they are a food source for parasites that help reduce the next generation of hornworms. Predators also kill large numbers of larvae that are less than 1 inch long. For this reason, hornworms less than 1 inch long are not considered when determining the economic threshold because they cause very little damage and have no effect on yield or quality. However, if a field has large numbers of hornworms less than 1 inch long, the field should be rechecked in 3 to 4 days. For optimum control of hornworms, direct insecticide sprays to the upper one-half of the plants. See the insecticide ratings in Table 7 and the labeled insecticides in Table 10. Several cultural practices help reduce the susceptibility of tobacco to hornworms. Early topping, early transplanting, effective sucker control, and fertilization with recommended rates of nitrogen help reduce late-season infestations. When used on an area-wide basis, stalk cutting and root destruction immediately after harvest reduces overwintering hornworm populations.

Aphids

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

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

1. **Preventive Control**

   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). This will make aphid control much easier for the rest of the season.

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

   c. **Assess control after 3 or 4 days.** It takes 1 to 3 days after application of most insecticides for the aphids to die. If control is not adequate, determine whether the weather conditions, spraying equipment, improper calibration, or other factors contributed to the poor control. If the aphids appear to be resistant, apply an insecticide in another group (Table 9).

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

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

3. **Cultural Control of Aphids**

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

a. **Avoid planting cole crops such as cabbage and turnips near greenhouses**. These plants are sources of aphids that can infest tobacco plants early in the growing season.

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

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

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

Tobacco Flea Beetle

Adult tobacco flea beetles feed on the leaves and stalks of tobacco, while the grubs or larvae feed on the roots. Extensive feeding on newly set transplants by both beetle stages may cause stunting and uneven stands. When checking tobacco fields for flea beetles, look for the characteristic shot-hole feeding damage, and then count the beetles on 20 plants (2 per field-sample location). **Apply treatments for flea beetles on newly set tobacco when there are 4 or more beetles per plant**. Larger plants can tolerate very high flea beetle densities. Apply an insecticide when the base of the lower leaves have a netted appearance or densities exceed 60 beetles per plant. Flea beetle control ratings for systemic and foliar insecticides are listed in Tables 2 and 7, respectively. Insecticides for flea beetle control are listed in Tables 3, 4, 5, and 10. Harvesting at the normal time, and stalk cutting and root destruction immediately after the last harvest are the most effective cultural practices for reducing flea beetle populations and the resulting damage the next year. Tobacco with nitrogen deficiency appears to be more susceptible to flea beetle damage after topping.

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

Managing thrips to control tomato spotted wilt virus

The tobacco thrips, *Frankliniella fusca,* is the primary vector of the tobacco pathogen, tomato spotted wilt virus (TSWV). TSWV caused moderate stand reductions in tobacco fields in parts of Virginia in 2002 but it has occurred at very low rates since then. Foliar treatments for thrips control are not effective for managing TSWV after the disease is observed in the field. However, tray drench or transplant water applications of Admire Pro or generic forms of imidacloprid and Platinum suppress TSWV. Tray drenches are more effective than transplant water treatments.

Tobacco splitworm

The tobacco splitworm or potato tuberworm, a leaf-mining caterpillar is sometimes a late season problem on tobacco. Splitworms live in tunnels or mines that appear as brown, tan, or grayish, translucent blotches on the leaves. Splitworms can also feed in the midvein and stalk. Old mines turn brown and brittle and may destroy over 50 percent of the leaf. Although the mines are most common on the lower leaves, they can occur on any leaf. Splitworm damage increases the amount of dead leaf tissue and may reduce crop yield and value. Since splitworms feed within the leaves, they are difficult to control with insecticides. Currently, only Coragen is registered for splitworm control on tobacco. However, Belt, Denim, Tracer, and acephate applied in high volumes of water provide fair to good control. Denim was the most effective treatment for splitworms in one trial. Early-season applications of Karate/Warrior appear to be effective but are rarely necessary and no early-season thresholds have been established.

It is important to avoid planting or storing Irish potatoes near tobacco fields because they are an important source of this pest in tobacco. If splitworm mines are observed on the lower leaves, the leaves should be harvested and cured as soon as possible. Since splitworms continue to develop inside the leaves after they are harvested, removing infested leaves and dropping them on the ground will not reduce the problem and may make it worse.

Insecticide Application Methods

Apply insecticides properly for optimum insect control. On small tobacco, obtain effective control by directing one solid-cone or hollow-cone nozzle per row to the bud. Operate equipment at 40 to 60 psi, do not exceed 5 miles per hour, and use at least 6 to 8 gallons of finished spray per acre. After tobacco is 2 ft. tall, use one or three nozzles per row. If three nozzles are used, orient the two side nozzles at 45 degree angles toward the upper $^1/_3$ of the plant. Use 20 to 50 gallons of spray mixture per acre at 40 to 60 psi. Set the nozzles 8 to 12 inches above the tobacco. Drop nozzles oriented to the undersides of the leaves and used in combination with one or three nozzles over the row may improve aphid, splitworm, and flea beetle control. Plant tobacco uniformly so that the space between rows is

constant. This makes it easier to orient the spray nozzles over the plants during the spraying operation.

Table 7. Rating of foliar insecticides for control of insect pests on 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	4	0	3*
Bacillus thuringiensis	0	2	0	0	0	5
Agree, Crymax/Dipel/Javelin/ Lepinox/XenTari						
Brigade/Capture	2	3	4	3	3	5
Belt	0	4	0	0	0	5
Coragen	0	4	0	0	0	5
Denim	0	4	0	0	0	4
Fulfill	3	0	0	0	0	0
Lannate	2	3	0	2	0	5
Orthene/Acephate/ Acephate 97UP	4	3	4	2	4	5
Provado/Nuprid	4	0	0	2	0	0
Sevin	0	2	3	2	3	4
Tracer	0	4	0	0	0	4
Karate/Warrior	1	3	3	3	3	5

[1] BW = Budworm; CW = Cutworm; FB = Flea Beetle; G = Grasshopper; HW = Hornworm. Rating is as follows 0 = not labeled, 1 = poor, 2 = fair, 3 = good, 4 = very good, 5 = excellent.

*effective, but not labeled.

Table 8. Restricted entry intervals and preharvest intervals for various insecticides used on 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 (Brigade/Capture)	12	Do not apply after layby
Bifenthrin + imidacloprid (Brigadier)	12	Do not apply after layby
Carbaryl (Sevin)	48	2
Chlorantraniliprole (Coragen)	4	1
Flubendiamide (Belt)	14	14
Imidacloprid (Nuprid/Provado) 1.6F	12	14
Lambda-cyhalothrin (Karate/Warrior 1CS)	24	40
Methomyl (Lannate)	48	7
Pymethozine (Fulfill)	12	14
Spinosad (Tracer)	4	3
Thiamethoxam (Actara/TMOXX))	12	14
Soil treatments		
Bifenthrin (Brigade/Capture)	12	Do not apply after layby
Chlorpyrifos (Lorsban/Lorsban Advance)	24	“
Ethoprop (Mocap)	48	“
Metaldehyde (Deadline Bullets)	12	“
Greenhouse seedling drench or transplant water treatments		
Acephate (Orthene/Acephate)	24	3
Bifenthrin (Brigade/Capture)	12	Do not apply after layby
Chlorantraniliprole (Coragen)	4	1
Imidacloprid (Admire Pro and various generics)	12	14
Lambda-cyhalothrin (Warrior/Karate)	12	40
Thiamethoxam (Platinum/TMOXX) 2F	12	14

Resistance Management

Minimizing Insecticide Residues

Pesticide residues are an important factor in the quality of cured tobacco that can cause some contractors to reject a tobacco crop. The following points help to minimize pesticide residues on the marketed crop.

- **Do not use any insecticides not labeled for use on tobacco.**
- **Do not use endosulfan (Cekulfan, Ednosulfan, Emusifiable Concentrate, Thiodan, Thiokill, Golden Leaf Tobacco Spray).** There are several insecticides that give equal or superior control. Some companies specify in their contacts that this chemical must not be used on the tobacco.
- **Follow the preharvest intervals closely.** The pyrethroids, bifenthrin (Brigade) and lambda-cyhalothrin (Karate/Warrior) have very long preharvest intervals. Bifenthrin should not be applied after layby and lambda-cyhalothrin has a 40-day preharvest interval.
- **Use insecticides with short preharvest intervals during the harvest period.** *Bt* and Tracer are good options for hornworms, Orthene provides effective control of aphids and some control of flea beetles, but there is usually no need for late-season applications.

The Insecticide Resistance Action Committee (IRAC) has grouped insecticides into mode of action (MOA) groups that are listed on many of the insecticide labels (Table 9). Avoid using insecticides with the same mode of action group to control an insect more than once during the growing season. This reduces the chances that an insect will develop resistance to the insecticides registered for tobacco.

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

Goup #	Mode of action	Chemical sub-group or active ingredient	Product name
1A	Acetylcholine esterase inhibitors	Carbamates	Lannate, Sevin, Temik
1B	Acetylcholine esterase inhibitors	Organophosphates	Orthene
3A	Sodium channel modulators	Pyrethroids, Pyrethrins	Brigade/Capture Karate/Warrior
4A	Nicotinic Acetylcholine receptor agonists / antagonists	Neoicothinoids	Actara, Admire Pro, Assail, Platinum, Provado
5	Nicotinic Acetylcholine receptor agonists	Spinosyns	Traces
6	Chloride channel activators	Avermectins	Denim
9	Selective feeding blockers	Pymetrozine	Fulfill
11	Microbial disruptors of insect midgut membranes	*Bacillus thuringiensis* var. *kurstaki Bacillus thuringiensis* var. *tenebrionenses*	Dipel, etc.
28	Ryanodine receptor inhibitor	Chlorantraniliprole Flubendiamide	Belt, Coragen

Table 10. Insects on Field Tobacco - Foliar Treatments

Insect	Insecticide and formulation	Rate per acre
Aphids	Acephate (Acephate AG) 75SP	$^2/_3$ to 1 lb
	(Acephate) 97UP	½ to ¾ lb
	(Orthene) 97PE	½ to ¾ lb
	Remarks and precautions: MOA = 1B Apply as a spray in 10 to 50 gal/acre. Use highest rate for heavy 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	0.6 to 1.7 oz
	(Assail) 30WG	1.5 to 4.0 fl oz
	Remarks and precautions: MOA = 4A Apply as a spray in at least 20 gal/acre. Do not apply to tobacco already treated with Admire Pro, Platinum, Provado, or Actara. Also provides fair control of hornworms.	
	Bifenthrin (Brigade/Capture) 2EC	2.56 to 6.4 fl oz
	Remarks and precautions: MOA = 4A Do not apply after layby. **Restricted use.**	
	Bifenthrin + imidaclorpid	3.8 to 6.4 fl oz
	(Brigadier) 1 + 1EC	2.56 to 6.4 fl oz
	Remarks and precautions: MOA = 3A Do not apply after layby. **Restricted use.**	
	Imidacloprid (Provado) 1.6F	2 to 4 fl oz
	(Nuprid and other generics) 1.6F	2 to 4 fl oz
	Remarks and precautions: MOA = 4A Apply as spray. **Do not apply to tobacco treated with Admire Pro, Assail, Platinum, Provado, or TMOXX.**	
	Methomyl (Lannate) 90SP	¼ to ½ lb
	(Lannate) 2.4LV	1 ½ pt
	Remarks and precautions: MOA = 1A Apply as a spray. Several applications may be necessary to control aphids. **Restricted Use**	
	Pymetrozine (Fulfill) 50WG	2 ¾ oz
	Remarks and precautions: MOA = 9 Do not apply more than twice or 5½ oz/acre/year. Allow 7 days between applications.	
	Thiamethoxam (Actara) 25WDG	2 to 3 oz
	Remarks and precautions: MOA = 4A Do not apply to tobacco already treated with Platinum, TMOXX, Admire Pro, Assail, or Provado. Apply only once during the growing season.	

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

Insect	Insecticide and formulation	Rate per acre
Armyworms (beet, fall and yellowstripped)	Bifenthrin (Brigade/Capture) 2EC	4.0 to 6.4 fl oz
	Remarks and precautions: MOA = 3A Do not apply after layby. **Restricted use.**	
	Emamectin benzoate (Denim) 0.16EC	6 to 12 fl oz
	Remarks and precautions: MOA = 6 **Restricted Use**. Apply in sufficient water for through coverage.	
	Lambda-cyhalothrin (Warrior) 1CS	1.9 to 3.8 fl oz
	(Karate with Zeon, Warrior II) 2.1SC	0.96 to 1.92 fl oz
	Remarks and precautions: MOA = 3A **Restricted Use**. Apply as a spray. Observe the 40-day preharvest interval. Orthene is labeled for armyworms on other crops.	
Budworms	Acephate (Acephate AG) 75SP	1 lb
	(Acephate) 97UP	¾ lb
	(Orthene) 97PE	¾ lb
	Remarks and precautions: MOA = 1B Apply as a spray. When using hand sprayer apply in 10 to 50 gal/acre.	
	Bacillus thuringiensis	
	(Agree) WG	1 to 2 lb
	(Crymax) WG	½ to 2 lb
	(Dipel) DF	½ to 1 lb
	(Dipel) ES	1 to 2 pt
	(Javelin) WG	1 to 1 ¼ lb
	(XenTari) WDG	½ to 2 lb
	Remarks and precautions: MOA = 11 Apply as a spray. **Do not allow diluted sprays to stand in the sprayer more than 12 hours**.	
	Bifenthrin ((Brigade/Capture) 2EC	4.0 to 6.4 fl oz
	Remarks and precautions: MOA = 3A **Restricted use.** Do not apply after layby.	
	Carbaryl (Sevin) 80S	1 ¼ to 2 ½ lb
	(Sevin XLR Plus) 4F	1 to 2 qt
	Remarks and precautions: MOA = 1A 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 10. Insects on Field Tobacco - Foliar Treatments (Cont'd)

Insect	Insecticide and formulation	Rate per acre
Budworms (cont'd)	Chlorantraniliprole (Coragen) 1.67SC	3.5 to 7.5 fl oz
	Remarks and precautions: MOA = 28 Make no more than 4 applications per acre per season. Do not use an adjuvant with applications.	
	Emamectin benzoate (Denim) 0.16EC	8 to 12 fl oz
	Remarks and precautions: MOA = 6 **Restricted Use**. Apply in sufficient water for through coverage. Apply before damaging infestations occur.	
	Flubendiamide (Belt) 4SC	2 to 3 fl oz
	Remarks and precautions: MOA = 28 Apply in at least 10 gal/acre. Do not exceed four applications per year.	
	Lambda-cyhalothrin (Karate/Warrior) 1CS	1.9 to 3.8 fl oz
	(Karate with Zeon, Warrior II) 2.1SC	0.96 to 1.92 fl oz
	Remarks and precautions: MOA = 3A **Restricted Use**. Apply as a foliar spray after field scouting indicates the population has reached the economic threshold. Observe the 40-day preharvest interval.	
	Methomyl (Lannate) 90SP	½ lb
	(Lannate) 2.4LV	1 ½ pt
	Remarks and precautions: MOA = 1A Apply as a spray. Make applications as needed. Direct the spray into the buds before buttoning. **Restricted Use.**	
	Spinosad (Tracer) 4F	1½ to 2 fl oz
	Remarks and precautions: MOA = 5 Use higher rates for large larvae or high infestations. Use at least 20 gal of water per acre.	
Cabbage loopers	Acephate (Acephate AG) 75SP	1 lb
	(Acephate) 97UP	¾ lb
	(Orthene) 97PE	¾ lb
	Remarks and precautions: MOA = 1B Apply as a spray in 10 to 50 gal of water	
	Bacillus thuringiensis **See rates and formulations under budworms**	
	Remarks and precautions: MOA = 11 Apply as a spray. **Do not allow prepared sprays to stand in tank more than 12 hrs.**	

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

Insect	Insecticide and formulation	Rate per acre
Cabbage loopers (cont'd)	Bifenthrin (Brigade/Capture) 2EC	4.0 to 6.4 fl oz
	Lambda-cyhalothrin (Warrior) 1CS	1.9 to 3.8 fl oz
	(Karate with Zeon, Warrior II) 2.1SC	0.96 to 1.92 fl oz
	Remarks and precautions: MOA = 3A Restricted Use. Apply as a spray. There is a 40-day preharvest interval for lambda-cyhalothrin. Do not apply bifenthrin after layby.	
	Methomyl (Lannate) 90SP	½ lb
	(Lannate) 2.4 LV	1 ½ pt
	Remarks and precautions: MOA = 1A Apply as a spray. **Restricted Use.**	
	Spinosad (Tracer) 4F	1½ to 2 fl oz
	Remarks and precautions: MOA = 5 Apply as a spray in at least 20 gal of water per acre.	
Cut-worms	Acephate (Acephate AG) 75SP	1 lb
	(Acephate) 97UP	¾ lb
	(Orthene) 97PE	¾ lb
	Remarks and precautions: MOA = 5 Apply as a spray overtop of plants in affected areas when 5% of plants are injured by cutworms. Make application during late afternoon using at least 25 gal of spray per acre.	
	Lambda-cyhalothrin (Warrior) 1CS	1.9 to 3.8 fl oz
	(Karate with Zion, Warrior II) 2.1SC	0.96 to 1.92 fl oz
	Remarks and precautions: MOA = 3A **Restricted Use**. Apply in the late afternoon when cutworms are causing damage. Do not apply within 40 days of harvest.	
Flea beetles	Acephate (Acephate AG) 75SP	$^2/_3$ lb
	(Acephate) 97UP	½ lb
	(Orthene) 97PE	½ lb
	Remarks and precautions: MOA = 1B Apply as a spray. Prime before treating	
	Bifenthrin (Brigade/Capture) 2EC	4.0 to 6.4 fl oz
	Remarks and precautions: MOA = 3A Do not apply after layby. **Restricted use.**	

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

Insect	Insecticide and formulation	Rate per acre
Flea beetles (cont'd)	Carbaryl (Sevin) 80S	1 ¼ lb
	(Sevin XLR Plus) 4F	1 qt
	Remarks and precautions: MOA = 1A 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: MOA = 4A Apply as spray. **Do not apply to tobacco already treated with imidacloprid (Admire Pro), acetimiprid (Assail), TMOXX, or Platinum (thiamethoxam).**	
	Lambda-cyhalothrin	
	(Warrior) 1CS	1.9 to 3.8 fl oz
	(Karate with Zion, Warrior II) 2.1SC	0.96 to 1.92 fl oz
	Remarks and precautions: MOA = 4A **Restricted Use**. Apply in sufficient water for coverage.	
	Methomyl (Lannate) 90SP	¼ to ½ lb
	(Lannate) 2.4LV	1 ½ pt
	Remarks and precautions: MOA = 1A Apply as a spray. **Restricted Use.**	
	Thiamethoxam (Actara) 25WDG	2 to 4 oz
	Remarks and precautions: MOA = 4A Do not apply to tobacco already treated with Admire Pro, Assail, Platinum, Provado, or TMOXX. Apply only once during the growing season.	
Grass-hoppers	Acephate (Acephate AG) 75SP	$^{1}/_{3}$ to $^{2}/_{3}$ lb
	(Acephate) 97UP	¼ to ½ lb
	(Orthene) 97PE	¼ to ½ lb
	Bifenthrin (Brigade/Capture) 2EC	4.0 to 6.4 fl oz
	Remarks and precautions: MOA is 1B for acephate and 3A for bifenthrin. Do not apply bifenthrin after layby. **Bifenthrin is restricted use.**	
	Carbaryl (Sevin) 80S	$^{2}/_{3}$ to 1 $^{7}/_{8}$ lb
	(Sevin XLR Plus) 4F	½ to 1 ½ qt
	Remarks and precautions: MOA = 1A Apply as a spray. Treat crop and a strip around field to reduce grasshopper movement into the field.	

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

Insect	Insecticide and formulation	Rate per acre
Grass-hoppers cont'd	Lambda-cyhalothrin Warrior) 1CS	1.9 to 3.8 fl oz
	(Karate with Zion, Warrior II) 2.1SC	0.96 to 1.92 fl oz
	Remarks and precautions: MOA = 3A **Restricted Use**. Apply in sufficient water for coverage. There is a 40-day preharvest interval.	
Hornworms	Acephate (Acephate AG) 75SP	$^{2}/_{3}$ lb in water
	(Acephate) 97UP	½ lb
	(Orthene) 97PE	½ lb
	Remarks and precautions: MOA = 1B Apply as a spray. Treat infested fields before worms are more than 1½ inches long. Direct insecticides toward the upper half of the plants. Prime before treatment.	
	Bacillus thuringiensis	
	(Agree) WSP	1 to 2 lb
	(Crymax) WG	½ to 2 lb
	(Dipel) DF	¼ to 1 lb
	(Dipel) ES	½ to 1 pt
	(Javelin) WG	$^{1}/_{8}$ to 1 ¼ lb
	(XenTari) WDG	½ to 2 lb
	Remarks and precautions: MOA = 11 Apply as a spray. Do not allow dilute sprays to stand in tank more than 12 hours. Dipel can be tank-mixed with maleic hydrazide (Royal MH-30).	
	Bifenthrin (Brigade/Capture) 2EC	4.0 to 6.4 fl oz
	Remarks and precautions: MOA = 3A Do not apply after layby. **Restricted use.**	
	Carbaryl (Sevin) 80S	1 ¼ to 2 ½ lb
	(Sevin XLR Plus) 4F	1 to 2 qt
	Remarks and precautions: MOA = 1A Apply as a spray.	
	Chlorantraniliprole (Coragen)1.67SC	3.5 to 7.5 fl oz
	Remarks and precautions: MOA = 28 Make no more than 4 applications per acre per season. **Do not use an adjuvant.**	

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

Insect	Insecticide and formulation	Rate per acre
Hornworms cont'd	Emamectin benzoate (Denim) 0.16EC	8 to 12 fl oz
	Remarks and precautions: MOA = 9 **Restricted Use**. Apply in sufficient water for through coverage before damaging infestations occur.	
	Flubendiamide (Belt) 4SC	2 to 3 fl oz
	Remarks and precautions: MOA = 28 Apply in at least 10 gal/acre. Do not exceed four applications per year.	
	Lambda-cyhalothrin (Warrior) 1EC	1.9-3.8 fl oz
	(Karate with Zion, Warrior II) 2.1SC	0.96 to 1.92 fl oz
	Remarks and precautions: MOA = 3A **Restricted Use**. Apply as a spray. There is a 40-day preharvest interval.	
	Methomyl (Lannate) 90SP	¼ to ½ lb
	(Lannate) 2.4LV	¾ to 1 ½ pt
	Remarks and precautions: MOA = 1A Apply as a spray. **Restricted Use.**	
	Spinosad (Tracer) 4F	1 to 2 fl oz
	Remarks and precautions: MOA = 5 Apply as a spray in at least 20 gal of water per acre.	
Japanese beetles	Acephate (Acephate AG) 75SP	$^2/_3$ to 1 lb
	(Acephate) 97UP	½ to ¾ lb
	(Orthene) 97PE	½ to ¾ lb
	Remarks and precautions: MOA = 1B Apply as a spray in 10 to 50 gal/acre. Prime before treating.	
	Bifenthrin (Brigade/Capture) 2EC	4.0 to 6.4 fl oz
	Remarks and precautions: MOA = 4A Do not apply after layby. **Restricted use.**	
	Carbaryl (Sevin) 80S	1 ¼ lb
	(Sevin) 50W	2 lb
	(Sevin XLR Plus) 4F	1 qt
	Imidacloprid (Provado) 1.6F	4 fl oz
	Thiamethoxam (Actara) 25WDG	3 oz
	Remarks and precautions: MOA is 1A for carbaryl and 4A for acetamiprid, imidacloprid, and thiamethoxam. Apply as a spray. Damage is usually less severe than it appears. Repeated applications with carbaryl or pyrethroids may flair up aphid populations.	

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

Insect	Insecticide and formulation	Rate per acre
Japanese beetles cont'd	Lambda-cyhalothrin (Warrior) 1EC	1.9 to 3.8 fl oz
	(Karate with Zion, Warrior II) 2.1SC	0.96 to 1.92 fl oz
	Remarks and precautions: MOA = 3A **Restricted Use. Apply as a spray. There is a 40-day preharvest interval.**	
Slugs	Metaldehyde (Dealine Bullets) 4 % Bait	12 to 40 lb
	Remarks and precautions: Apply as a broadcast treatment to the soil surface in the late evening. Metaldehyde is most effective after irrigation or a rain.	
Stink bugs	Acephate (Acephate AG) 75SP	$^2/_3$ to 1 lb
	(Acephate) 97UP	½ to ¾ lb
	(Orthene) 97PE	½ to ¾ lb
	Remarks and precautions: MOA = 1B Apply as a spray. Stinkbug injury is usually much less severe than it appears**.**	
	Bifenthrin (Brigade/Capture) 2EC	4.0 to 6.4 fl oz
	Remarks and precautions: MOA = 3A Do not apply after layby. **Restricted use.**	
	Lambda-cyhalothrin (Warrior) 1EC	1.9 to 3.8 fl oz
	(Karate with Zion, Warrior II) 2.1SC	0.96 to 1.92 fl oz
	Remarks and precautions: MOA = 3A **Restricted Use**. Apply as a spray. There is a 40-day preharvest interval. **Restricted use.**	

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

Insect	Insecticide and formulation	Rate per acre
Thrips	Acephate (Acephate AG) 75SP	$^{2}/_{3}$ to 1 lb
	(Acephate) 97UP	½ to ¾ lb
	(Orthene) 97PE	½ to ¾ lb
	Remarks and precautions: MOA = 1A Apply as a spray in 10 to 50 gal/acre. Use highest rate for heavy infestations or if control was poor with previous application. Prime before treating. Foliar applications for thrips control are not effective for reducing tomato spotted wilt virus after the disease is observed.	
	Bifenthrin (Brigade/Capture) 2EC	4.0 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
	(Karate with Zion, Warrior II) 2.1SC	0.96 to 1.92 fl oz
	Remarks and precautions: MOA = 3A 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. **Restricted Use.**	
Tobacco splitworm/ potato tuberworm	Chlorantraniliprole (Coragen) 1.67SC	3.5 to 7.5 fl oz
	Remarks and precautions: MOA = 28 Make no more than 4 applications per acre per season. Do not use an adjuvant.	
Whitefringed beetle	No chemicals are currently registered for whitefringed beetle control on tobacco. In one trial, imidacloprid and thiamethoxam applied as tray drench and transplant water treatments provided good control.	
	Remarks and precautions: Cultural control: Rotate tobacco with grass crops. Control legumes and broadleaf weeds. Do not plant tobacco after legumes.	

HARVESTING, CURING, STRIPPING, MARKETING AND TOBACCO SPECIFIC NITROSAMINES

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Harvesting

Growers should only harvest mature, ripe tobacco. Burley tobacco usually matures and is ready for harvest 3 to 5 weeks after topping, at which time the upper 1/3 of the plant should have a distinct pale green to yellow appearance, and the bottom of the plant should be completely yellow. The midribs of the leaves should fade from a green color to a pale yellow color as the plant ripens. The amount of nitrogen fertilizer applied and soil moisture will have some influence on the time of maturity and, more directly, the quality of the tobacco at maturity. There is 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, added growth and weight of the upper leaves will usually more than make up for the loss of down-stalk leaves. Generally, growers in the southwest portion of Virginia gain a tremendous amount of yield by waiting at least 4 to 5 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 4 weeks after topping and can start to decrease between 4 and 5 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 a week they should let the tobacco stand 4 weeks after topping. However, if it's going to take longer they should start at 3 weeks after topping. Burley tobacco should not be cut sooner than 3 weeks after topping.

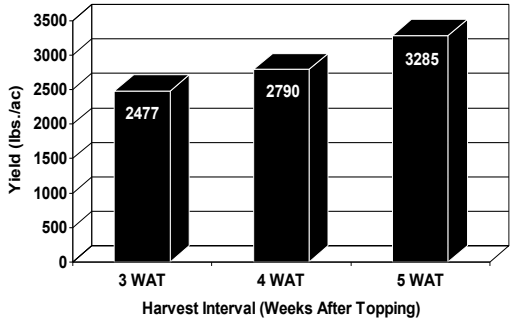

Figure 1. Burley tobacco yields averaged across ten varieties harvested 3, 4, and 5 weeks after topping Glade Spring, VA 2006.

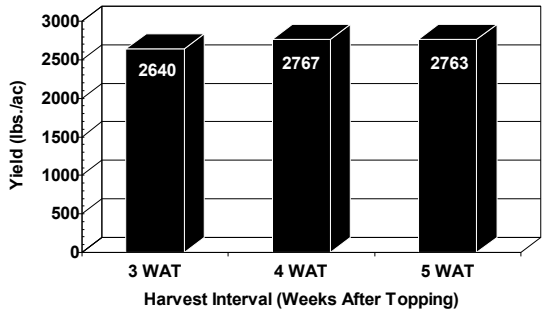

Figure 2. Burley tobacco yields averaged across ten varieties harvested 3, 4, and 5 weeks after topping, Blackstone, VA 2007.

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

Under ideal conditions for the best quality burley tobacco should be left in the field on the stick only long enough to wilt sufficiently enough to handle without breaking. However, in many tobacco is so big and heavy it requires more time to loose enough moisture to become light enough for workers to handle. Tobacco should not be left in the field longer than 3 to 5 days unless it is scaffolded, otherwise quality will be sacrificed. It is especially important that the tobacco not be allowed to get muddy. Tobacco placed on scaffolds may be left in the field for up to 12 days with little or no damage from the weather and will lose about 40% in weight.

Curing

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

Optimum curing conditions occur when temperature is in the general range of 60-90^{O}F and relative humidity is 70-75%. In the early stages of curing, it is impractical to attempt to maintain these optimum ranges through a 24-hour period. In normal weather, the humidity within a barn filled with

green tobacco will approach 100% each night. A good cure can still be obtained if ventilation is provided to dry out the barn the next day.

Most burley barns in Southwest portion of Virginia are extremely open and allow for over ventilation. Thus, when ambient conditions are drier than ideal, tobacco can cure up "variegated", "K" or "paw-pawed". This tobacco has a mottled or yellow color to the leaf. This is a result of an incomplete cure where the tobacco simply dried down rather than cured down. Ideally barns should be built or remodeled to allow for management when ambient conditions are less than ideal.

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

Supplemental heat can be an advantage during rainy weather or prolonged periods of high humidity. The objective in using heat is to raise the temperature within the barn only 6-8^{o}F or just enough to dry the leaf surface and thereby prevent the proliferation of organisms that cause houseburn. Some type of heat spreader should be used on burners to prevent hot spots that can set undesirable colors in the curing leaf. Maximum temperature increases should not exceed 10-15^{o}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 proper manipulation of barn equipment. Generally, ventilators and doors should be open during fair weather and closed during rainy weather and at night. This process can be reversed during extremely dry weather when tobacco is curing too fast. New barns should be located on high ground with good air circulation and with the long side exposed to prevailing winds.

Much tobacco in Virginia is cured on some type of field-curing structure. The curing environment is managed primarily by stick spacing and cover management. Stick spacing should be much closer in this type of structure, approximately 4-5 inches. **All curing structures should be covered & managed**. Curing burley tobacco without 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 the sides should be lowered during the day to slow down the curing process. Tobacco should be removed from the field-curing structure as soon as possible after the curing process is completed. This will minimize damage due to weather, primarily wind.

Stripping and Marketing

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

Generally there are four distinguishable grades of tobacco on a stalk. These grades include Flyings (X), Lugs (C), Leaf (B), and Tips (T). The flyings group (X) consists of leaves grown at the bottom of the stalk. These leaves are flat and have a blunt of oblate tip. They are relatively thin bodied and show a certain amount of injury. The lug group (C) consists of leaves which grow above the flyings and up to about midportion of the stalk. These leaves have a rounded tip and , when cured have a tendency to fold and conceal the midrib. They are thin to medium bodied. The leaf group (B) is made up of leaves grown above the lugs. The cured leaves, especially from the upper stalk position, have a tendency to fold and conceal the face of the leaf. These leaves are medium to heavy bodied. The tips (T) are those top 3 or 4 leaves at the top of the stalk. They have same general characteristics of the leaf group. The practice of mixing grades may offer a slight labor savings, but it does not meet the needs of most buyers. With an over-supply situation and a weak market, mixed tobacco generally sells for less than properly sorted good quality leaf. Three groups is the least number that should be used in preparing any burley crop for market. Currently much of the burley purchased in Virginia is purchased through a contract rather than the auction system. 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 22-24 leaves. For pictures of burley grades and more information on grading burley tobacco
go to the Southern Piedmont website:
http://www.arec.vaes.vt.edu/southern-piedmont

Tobacco should not be stripped or baled in too high or too low moisture content. Dry leaf lamina is easily shattered and ruins the usability of the leaf. High moisture tobacco will easily over-heat and mold and will

damage in handling. It has also been proven that tobacco stored at a high Moisture level results in higher levels of tobacco specific nitrosamines (TSNA's). Moisture content should be between 18 and 22% for proper handling and storage. Many tobacco manufactures and leaf dealers will reject tobacco if above a moisture content of 23.9 percent.

Large Bales

Most buyers have shown a preference for tobacco to be marketed in large flue-cured type bales. These bales range in weight from 550-650 pounds. By requiring the handling of burley tobacco in bulk and by allowing "tangled leaf" baling compared to the oriented-leaf method used in traditional burley bales large growers can save a significant amount of labor. However, the labor savings must be balanced between the increased equipment and facility costs to operate the large bale system. Growers that continue to market burley tobacco in traditional small bales are usually penalized in price for their tobacco. Small bales may soon be unacceptable for marketing burley tobacco.

Figure 3. Example of a large baler and bales of burley tobacco.

Tobacco Specific Nitrosamines (TSNA)

Nitrosamines are nitrogenous compounds, some of which are carcinogenic. They are found in a wide range of food and cosmetic products, as well as in tobacco. TSNAs, tobacco specific nitrosamines, are so called because they are formed only from tobacco alkaloids and found only in tobacco leaf and in the particulate phase of tobacco smoke. With the current emphasis on the health risks of tobacco, TSNA reduction has become a major issue for the tobacco industry.

Several tobacco-specific nitrosamines have been identified, but interest has focused on the four most important: NNK, NNN, NAT and NAB. Of these, NNN is the most important in burley and dark tobacco.

How Are TSNAs Formed?

Negligible amounts of TSNAs are present in freshly harvested green tobacco. They are mainly formed during curing, specifically during the late yellowing to early browning stage. This is usually in the two-week period from three weeks to five weeks after harvest.

TSNAs are formed by the nitrosation of tobacco alkaloids (addition of a nitrogen and an oxygen atom to the alkaloid molecule). NNN is formed by the nitrosation of the alkaloid nornicotine. The nitrosating agent in air-cured tobacco is usually nitrite, derived from the reduction of leaf nitrate by the action of microbes during curing. Both the alkaloid and the nitrosating agent are necessary for the formation of TSNAs. Any practices or conditions which increase the accumulation of either of these groups of compounds would be expected to increase TSNAs.

Best management practices for minimizing TSNAs

TSNA formation is a very complex process, and one cannot consider any of the factors contributing to it in isolation. All of these factors interact, and that is why different treatments sometimes result in TSNA differences and sometimes do not. The following is a list of practices that will contribute to lowering TSNAs.

- Use LC or screened seed
- Choose the most suitable variety, with the appropriate disease resistance package
- Use no more nitrogen than necessary to optimize yield
- Avoid spring applications of muriate fertilizers
- If sidedressing, apply sidedressing at the recommended 4-5 weeks after transplanting.
- Harvest at correct maturity, ideally 4 weeks after topping
- Avoid overpacking the barn and space sticks and plants on sticks evenly
- Manage air-curing carefully, ensuring adequate but not excessive ventilation, and avoid houseburn
- Allow burley tobacco to come into case naturally and use minimal artificial casing for dark tobacco, ideally misting systems instead of steam
- Do not leave tobacco in storage longer than necessary; strip, bale and deliver tobacco as soon as possible
- Keep moisture in the leaf as low as possible; do not put high moisture tobacco into storage, and do not deliver tobacco with moisture higher than that specified in the contract.

BURLEY TOBACCO WORKER SAFETY

Danny R. Peek, Extension Specialist

Burley Tobacco Production requires much attention to worker safety primarily because of its labor intensive nature. Most of the labor requirements for burley tobacco production is hands-on. As with many agronomic crops burley tobacco requires certain crop protectants to be applied during production to establish profitable yields and quality. Grower and applicator safety is of utmost importance. Growers should have or obtain a pesticide applicator's license and all pesticide applications should be made or supervised by a certified applicator. Most all burley is hand harvested and requires the use of a sharp hatchet like "Tobacco knife" to cut plants and a very sharp spear like instrument is used to place plants on a stick. Workers must be properly trained to use these tools to minimize risk of injury. Once tobacco is cut and sticks are picked up out of the field workers climb up into the barn and stand on tier rails to hang tobacco. All tier rails in barns and structures need to be checked for strength and stability prior to workers climbing or putting weight on them. The harvest and housing process can put workers at risk of green tobacco sickness. Especially when workers are working in tobacco that is wet. A recent development in market preparation, primarily in the marketing of big bales, requires additional attention to worker safety. These are just some of the areas that growers need to be concerned with providing worker safety during burley tobacco production.

Applying Crop Protectants

Burley tobacco generally requires herbicides, insecticides, fungicides/plant activators, and plant growth regulators during the production season. Most applications are made mechanically with a tractor pulled or self powered sprayer. However, some growers still hand-apply sucker control materials to burley tobacco. All workers should be trained in pesticide safety and all applications should be made and/or supervised by a certified applicator to ensure worker safety. Any workers applying crop protectants should be provided proper protective equipment determined by the label of the compound being applied. All fields where applications have been made should be properly posted to clearly inform workers of all pesticide applications. Workers should be properly informed of reentry intervals for fields that have been treated with a crop protectant. Workers should be familiar with the product label.

Cutting & Housing Tobacco

Workers should be trained to use a tobacco knife and spear to reduce the risk of being injured during cutting. Workers can maintain better control of the spear if sticks are sharpened on both ends allowing the stick to be pushed into the soil and the spear placed securely on the other end. Less

experienced workers can work in teams to reduce the risk of injury. However this will likely reduce harvest efficiency. After tobacco is cut and wilted workers remove tobacco from the field and house it in curing facilities. Hanging tobacco in barns or other curing structures can be very dangerous if proper precautions are not taken. Prior to harvest all curing structures should be evaluated for tier rail strength and stability. Tier rails should be properly spaced and secured to maximize worker safety.

Green Tobacco Sickness

Workers should be cautioned that cutting or housing wet tobacco could cause Green Tobacco Sickness. Green tobacco sickness (GTS) is an illness resulting from the dermal absorption of dissolved nicotine. Nicotine is an alkaloid present in tobacco and is very water soluble making it much easier to be exposed. The biggest risk of exposure for workers is during topping, harvest, and housing tobacco. Generally workers are more likely to be effected by GTS if exposed for long periods of time to wet tobacco due to the water solubility of nicotine. Individual response to GTS varies based on dose, sensitivity, and size of worker. Workers that use tobacco products seem to be more tolerant to nicotine exposure. Symptoms generally occur 3-17 hours after exposure. Symptoms include nausea, vomiting, dizziness, and increased heart rate. Symptoms can exist 1-3 days so workers should follow instructions of a medical professional.

To reduce risk of GTS workers should avoid contact with wet tobacco. Tobacco should be allowed to dry prior to topping, cutting, and housing. If workers must work in wet tobacco they should be provided proper waterproof clothing to protect themselves from becoming wet from the tobacco. Workers should also be careful to not overheat since generally this clothing doesn't allow for good air circulation. If worker's clothes do become wet they should change out of wet clothes into dry clothes and wash wet clothes prior to wearing again. If workers become ill due to GTS they should be provided medical attention.

Market Preparation

Market preparation requires more hours of hand labor than all other aspects of production combined. The process of maximizing efficiency has lead to the marketing of large bales, replacing small traditional bales. These bales have introduced new risks to workers in both making and handling. Most large balers operate by hydraulics from tractors or self contained units. Workers should stay clear of pressing mechanism when baler is in use. **Workers should never climb inside the baler while making bales.** Large bales range in size from 550 to 650 pounds with a dimension of approximately 42 inch cube. Thus, handling these bales generally requires a tractor or front end loader. Make sure specific and adequate space is designated for the baling process. Worker safety should never be compromised in the interest of efficiency.

EPA Worker Protection Standards for Commonly Used Pesticides for Burley Tobacco 2011

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

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

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

Worker Protection Standards Tobacco Pesticides

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

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

Worker Protection Standards Tobacco Pesticides

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2] Applicators and Other Handlers	To Enter Treated Area Within REI[3]	Worker Notification Oral	Posted
Actara 25 WDG (thiamethoxam) EPA Reg. No. 100-938 Syngenta	Caution	12 hrs.	long-sleeved shirt, waterproof glovers, shoes plus socks	coveralls, waterproof gloves, shoes plus socks	either	either
Actigard 50WG (acibenzolar-s-methyl) EPA Reg. No. 100-922 Syngenta Crop Protection	Caution	12 hrs	long-sleeved shirt and long pants; chemical resistant gloves made of any waterproof material such as polyethylene; shoes plus socks	coveralls; chemical-resistant gloves made of any waterproof material such as polyethylene or polyvinyl chloride; shoes plus socks	none	none
Admire® 4.6 Soluble Concentrate (imidacloprid) EPA Reg. No. 3125-422 Bayer	Caution	12 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either
Agree® *(Bacillus thuringiensis var. aizawai* strain) EPA Reg. No. 100-733 Thermo Trilogy	Caution	4 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks; protective eyewear; dust/mist filtering respirator	coveralls; waterproof gloves; shoes plus socks; protective eyewear	either	either

Worker Protection Standards Tobacco Pesticides

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2] Applicators and Other Handlers	To Enter Treated Area Within REI[3]	Worker Notification Oral	Posted
Agri-Mycin 17 *(Streptomycin sulfate)* EPA Reg. No. 55146-96 Nufarm Americas Inc.	Caution	12 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves made of any waterproof material; shows plus socks	coveralls over long-sleeved shirt and long pants; chemical-resistant gloves made of any waterproof material; shows and chemical-resistant footwear	either	either
Aim EC *(carfentrazone)* EPA Reg. No. 279-3241 FMC Corporation **Aim EW** *(carfentrazone)* EPA Reg. No. 279-3242 FMC Corporation	Caution	12 hrs.	long-sleeved shirt and long pants; waterproof gloves, shoes plus socks	coveralls, waterproof gloves; shoes plus socks	either	either
Alliette WDG Fungicide (Aluminum tris (o-ethylphosphonate) EPA Reg. No. 264-516 Bayer CropScience	Caution	12 hrs.	long-sleeved shirt and long pants; waterproof gloves, shoes plus socks; protective eyewear	coveralls, waterproof gloves, shoes plus socks; protective eyewear	either	either

Worker Protection Standards Tobacco Pesticides

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2] Applicators and Other Handlers	To Enter Treated Area Within REI[3]	Worker Notification Oral	Posted
Alias ® 2F	Caution	12 hrs.	long-sleeved shirt and long pants, waterproof gloves, shoes plus socks, and chemical resistant headgear for overhead exposure	coveralls chemical resistant gloves and shoes plus socks	either	either
Antak® (C10 fatty alcohol) EPA Reg. No. 19713-18 Drexel	Warning	24 hrs.	coveralls over short-sleeved shirt and short pants; waterproof gloves; chemical-resistant footwear plus socks; protective eyewear; chemical-resistant headgear for overhead exposure; chemical-resistant apron when cleaning equipment, mixing or loading	coveralls over short-sleeved shirt and short pants; waterproof gloves; chemical-resistant footwear plus socks; protective eyewear; chemical-resistant headgear for overhead exposure	either	either
Assail ® 70WP EPA Reg. No. 8033-23-4581 Cerexagri, Inc.	Caution	12 hrs.	long-sleeved shirt and long pants, waterproof gloves, shoes plus socks, and chemical resistant headgear for overhead exposure	coveralls, waterproof gloves and shoes plus socks	either	either
Belt (Flubendiamide) EPA Reg. No. 264-1025 Bayer CropScience	Caution	12 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves (such as natural rubber); shoes plus socks	coveralls, chemical-resistant gloves such as Barrier Laminate, Butyl rubber, Nitrile rubber, or Viton, and shoes plus socks	either	either
Brigade 2EC (bifenthrin) EPA Reg. NO. 279-3313 FMC Corporation	Warning	12 hrs.	long-sleeved shirt and long pants; chemical resistance; gloves such as Barrier Laminate or Nitrile rubber or Vitron and shoes plus socks and protective eyewear	coveralls, chemical-resistant gloves such as Barrier Laminate, Butyl rubber, Nitrile rubber, or Viton or neoprene rubber, and shoes plus socks	either	either

Worker Protection Standards Tobacco Pesticides

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2] Applicators and Other Handlers	To Enter Treated Area Within REI[3]	Worker Notification Oral	Posted
Brigadier (bifenthrin + imidacloprid) EPA Reg. No. 729-3332 FMC Corporation	Warning	12 hrs.	long-sleeved shirt and long pants; shows plus socks	coveralls, chemical-resistant gloves such as Barrier Laminate, Butyl rubber, Nitrile rubber, or Viton, and shoes plus socks	either	either
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 ventilated long-sleeved shirt and long pants; shoes and socks; fullface shield or safety glasses with brow and temple shields	non-handlers prohibited	yes	yes
Butralin (butralin) EPA Reg. No. 33688-4-400 Chemtura	Danger	12 hrs.	long-sleeved shirts and long pants; chemical-resistant gloves; shoes and socks; and protective eyewear	coveralls; chemical-resistant gloves; shoes and socks; and protective eyewear	either	either
Capture 2 EC	Warning	12 hrs.	long-sleeved shirt and long pants, chemical-resistance gloves, such as Barrier Laminate or Nitrile rubber or Vitron and shoes plus socks and protective eyewear	coveralls, chemical-resistant gloves such as Barrier Laminate, Butyl rubber, Nitrile rubber, or Viton or neoprene rubber, 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-sleeved shirt and long pants; shoes and socks; fullface shield or safety glasses with brow and temple shields. Do not wear goggles.	non-handlers prohibited	yes	yes

Worker Protection Standards Tobacco Pesticides

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2] Applicators and Other Handlers	To Enter Treated Area Within REI[3]	Worker Notification Oral	Posted
Command® 4 EC (clomazone) EPA Reg. No. 279-3053 FMC	Warning	12 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves, such as Barrier Laminate or Viton; shoes plus socks; and protective eyewear	coveralls; chemical-resistant gloves, such as Barrier Laminate or Viton; shoes plus socks; and protective eyewear	either	Either
Command ® 3ME EPA Reg. No. 279-3158 FMC	Warning	12 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves, such as Barrier Laminate or Viton; shoes plus socks; and protective eyewear	coveralls; chemical-resistant gloves, such as Barrier Laminate or Viton; shoes plus socks; and protective eyewear	either	either
Coragen 1.67SC (chlorantranilprole) EPA Reg. No. 352-729 Dupont	None	4 hrs.	long-sleeved shirt and long pants; shoes plus socks	shirt, pants; and shoes	either	either
Condor® (*Bacillus thuringiensis* subspecies *kurstaki* strain EG 2348) EPA Reg. No. 55638-7 Ecogen **Condor® XL** (*Bacillus thuringiensis* subspecies *kurstaki* strain EG 2348) EPA Reg. No. 55638-33 Ecogen	Caution	4 hrs.	long-sleeved shirt and long pants; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either

Worker Protection Standards Tobacco Pesticides

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2] Applicators and Other Handlers	To Enter Treated Area Within REI[3]	Worker Notification Oral	Posted
Crymax® (*Bacillus thuringiensis)* EPA Reg. No. 55638-34 Ecogen	Caution	4 hrs.	long-sleeved shirt and long pants; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either
Deadline Bullets 4G (metaldehyde) EPA Reg. No. 64864-00002-AA-00000 Pace International	Caution	12 hrs.	long-sleeved shirt and long pants; shoes plus socks	shirt, pants; and shoes	either	either
Denim 0.16EC	Danger	48 hrs.	coveralls worn over long-sleeved shirt and long pants, chemical-resistant gloves, chemical-resistant footwear plus socks, protective eyewear, chemical-resistant apron when cleaning equipment, mixing or loading	coveralls over long-sleeved shirt and long pants chemical-resistant gloves, chemical-resistant footwear plus socks	either	either
Devrinol ® 2-E (napropamide) EPA Reg. No. 10182-219-70506 United Phosphorus, Inc.	Danger	12 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves, such as barrier laminate or Viton ≥ 14 mils; shoes plus socks; protective eyewear	coveralls; chemical resistant gloves, such as barrier laminate or Viton ≥ 14 mils; shoes plus socks; protective eyewear	either	either
Devrinol® 50-DF (napropamide) EPA Reg. No. 10182-258-70506 United Phosphorus, Inc.	Caution	12 hrs.	long-sleeved shirt and long pants; waterproof gloves, shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either

Worker Protection Standards Tobacco Pesticides

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2] Applicators and Other Handlers	To Enter Treated Area Within REI[3]	Worker Notification Oral	Posted
Dipel® 10G (*Bacillus thuringiensis*) EPA Reg. No. 275-55 Valent	Caution	4 hrs.	long-sleeved shirt and long pants; shoes plus socks	coveralls; shoes plus socks; waterproof gloves	either	either
Dipel® ES (*Bacillus thuringiensis*) EPA Reg. No. 73049-17 Valent	Caution	4 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either
Dipel® DF (*Bacillus thuringiensis*) EPA Reg. No. 275-103 Valent	Caution	4 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either
Dipel ®SG Plus (*Bacillus thuringiensis*) EPA Reg. No. 275-96 Valent	Caution	4 hrs.	long-sleeved shirt and long pants; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either
Di-Syston® 15 G (disulfoton) EPA Reg. No. 3125-172 Bayer	Danger	48 hrs.	coveralls over short-sleeved shirt and short pants; waterproof gloves; chemical-resistant footwear plus socks; chemical-resistant headgear; chemical-resistant apron; respirator	coveralls over short-sleeved shirt and short pants; waterproof gloves; chemical-resistant footwear plus socks; chemical-resistant headgear for overhead exposure	yes	yes

Worker Protection Standards Tobacco Pesticides

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2] Applicators and Other Handlers	To Enter Treated Area Within REI[3]	Worker Notification Oral	Posted
Dithane® DF Rainshield (mancozeb) EPA Reg. No. 707-180 SLN No. VA 940001 Dow AgroSciences	Caution	24 hrs.	coveralls over long-sleeved shirt and long pants; chemical resistant gloves such as butyl rubber or nitrile rubber or neoprene rubber or Viton; shoes plus socks; chemical-resistant apron when cleaning equipment, mixing or loading	coveralls over long-sleeved shirt and long pants; chemical resistant gloves, such as butyl rubber or nitrile rubber or neoprene rubber or Viton; shoes plus socks; protective eyewear	either	either
Drexalin Plus	Caution	24 hrs.	long-sleeved shirt and long pants; socks, shoes, and chemical resistant gloves made of any waterproof material such as Viton or Barrier laminate; chemical-resistant apron when cleaning equipment, mixing or loading	long-sleeved shirt and long pants, socks; shoes, and chemical-resistant gloves made of any waterproof material, chemical-resistant headgear for overhead exposure	either	either
Fair 85® (C6, - C12 fatty alcohols) EPA Reg. No. 51873-7 Fair Products	Warning	24 hrs.	long-sleeved shirt and long pants; chemical resistant gloves such as barrier laminate or butyl rubber or nitrile rubber or neoprene or polyvinyl chloride or Viton; shoes plus socks; protective eyewear	coveralls; chemical resistant gloves such as barrier laminate or butyl rubber or nitrile rubber or neoprene or polyvinyl chloride or Viton; shoes plus socks; protective eyewear	either	either

Worker Protection Standards Tobacco Pesticides

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2] Applicators and Other Handlers	To Enter Treated Area Within REI[3]	Worker Notification Oral	Posted
Fair Plus® (maleic hydrazide) EPA Reg. No. 51873-2 Fair Products	Caution	12 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks; protective eyewear	coveralls; waterproof gloves; shoes plus socks; protective eyewear	either	either
Fair-30® EPA Reg. No. 51873-9 Fair Products **Fair 80 SP®** EPA Reg. No. 51873-17	Caution	12 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks; protective eyewear	coveralls; waterproof gloves; shoes plus socks; protective eyewear	either	either
Firewall (Streptomycin sulfate) EPA Reg. NO. 80990-4-82695 United Phosphorus Inc. **Fire Wall 17 WP** (streptomycin sulfate) EPA Reg. No. 80990-4 AgroSource Inc.	Caution	12 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves made of any waterproof material; shoes plus socks; MSHA/NIOSH approved dust/mist respirator with any R, P, or HE filter	coveralls over long-sleeved shirt and long pants; chemical-resistant gloves made of any waterproof material; shoes plus socks	either	either

Worker Protection Standards Tobacco Pesticides

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 Oral	Worker Notification Posted
FluPro (flumetralin) EPA Reg. No. 73631-2-400 Chemtura	Warning	24 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves made of any waterproof material such as nitile, butyl, neoprene, or barrier laminate; chemical resistant footwear plus socks	long-sleeved shirt and long pants; chemical-resistant gloves made of any waterproof material such as nitrile, butyl, neoprene or barrier laminate; chemical resistant footwear plus socks; protective eyewear	either	either
Forum (dimethomorph) EPA Reg. No. 241*-427 BASF Corporation	Caution	12 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves; shoes plus socks	long-sleeved shirt and long pants; chemical-resistant gloves; shoes plus socks	either	either
FST-7® (C10 fatty alcohol and maleic hydrazide) EPA Reg. No. 51873-6 Fair Products	Danger	24 hrs.	long-sleeved shirt and long pants; chemical resistant gloves such as Barrier Laminate or butyl rubber or nitrile rubber or neoprene or polyvinyl chloride or Viton; shoes plus socks; protective eyewear	coveralls; chemical resistant gloves such as Barrier Laminate or butyl rubber or nitrile rubber or neoprene or polyvinyl chloride or Viton; shoes plus socks; protective eyewear	either	either
Fulfill® 50WDG (pymetrozine) EPA Reg. No. 100-192 Syngenta	Caution	12 hrs.	long-sleeved shirt and long pants, waterproof gloves, shoes plus socks	long-sleeved shirt and long pants, waterproof gloves, shoes plus socks	either	either

Worker Protection Standards Tobacco Pesticides

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

Worker Protection Standards Tobacco Pesticides

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 Oral	Worker Notification Posted
Lorsban® 4E (chlorpyrifos) EPA Reg. No. 62719-220 **Lorsban Advanced** (chlorpyrifos) EPA Reg. No. 62719-591 Dow AgroSciences	Warning	24 hrs.	long-sleeved shirt and long pants; chemical resistant gloves; chemical resistant footwear plus socks, chemical resistant headgear for overhead exposure, a NIOSH respirator with R, P, or HE filter	coveralls; waterproof and chemical-resistant gloves; chemical resistant footwear and chemical resistant headgear for overhead exposure	yes	yes
Manzate Pro-Stick (mancozeb) EPA Reg. No. 352-704 SLN No. VA-080004 Dupont Crop Protection	Caution	24 hrs.	coveralls over long-sleeved shirt and long pants; chemical resistant gloves; shoes plus socks	coveralls over long-sleeved shirt and long pants; chemical resistant gloves; shows plus socks	either	either
MetaStar 2E AG (metalaxyl) EPA Reg. 71532-5-66330 Arysta Life Science North America Corp.	Warning	48 hrs.	long-sleeved shirt and long pants; chemical resistant gloves, shows plus socks; protective eyewear	coveralls; chemical-resistant gloves; shows plus socks; protective eyewear	either	either
Nuprid 2F (imidacloprid) EPA Reg No. 228-484 **Nuprid 1.6 F** EPA Reg. No. 228-488 Nufarm Americas, Inc.	Caution	12 hrs.	long-sleeved shirt and long pants; waterproof gloves; shows plus socks	coveralls; waterproof gloves; shows plus socks	either	either

Worker Protection Standards Tobacco Pesticides

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 Oral	Worker Notification Posted
Off-Shoot T® (C6 - C12 fatty alcohols) EPA Reg. No. 57582-3 Cochran	Warning	24 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks; protective eyewear	coveralls; waterproof gloves; shoes plus socks; protective eyewear	either	either
Orthene® 75 S (acephate) EPA Reg. No. 59639-26AA **Orthene ® 97** EPA Reg. No. 59639-91 Valent	Caution	24 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks; chemical resistant headgear for overhead exposure	coveralls; waterproof gloves; shoes plus socks; chemical resistant headgear for overhead exposure	either	either
Pasada ® 1.6 F *(imidacloprid)* EPA Reg. No. 264-763-6622 Makhteshim Agan of North America, Inc.	Caution	12 hrs.	long-sleeved shirt and long pants, waterproof gloves; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either
Pencozeb 75DF *(mancozeb)* EPA Reg. No. 70506-185 SLN No. VA-080005 United Phosphorus Inc.	Caution	24 hrs.	coveralls over long-sleeved shirt and long pants; chemical resistant gloves; shoes plus socks	coveralls over long-sleeved shirt and long pants; chemical resistant gloves; shoes plus socks	either	either

Worker Protection Standards Tobacco Pesticides

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2] Applicators and Other Handlers	To Enter Treated Area Within REI[3]	Worker Notification Oral	Posted
Platinum ® 2SC (thiamethoxam) EPA Reg. No. 100-939 Syngenta	Caution	12 hrs.	long-sleeved shirt, waterproof gloves, shoes plus socks	coveralls, shirt, waterproof, gloves, shoes plus socks	either	either
Poast® (sethoxydim) EPA Reg. No. 7969-58 SLN No. VA-980004 BASF Corp.	Warning	12 hrs.	chemical resistant gloves; coveralls over short-sleeved shirt and short pants; chemical resistant footwear plus socks; protective eyewear; chemical resistant headgear for overhead exposure; Other - chemical resistant apron when cleaning equipment mixing and loading	chemical resistant gloves; coveralls over short-sleeved shirt and short pants; chemical resistant footwear plus socks; protective eyewear; chemical resistant headgear for overhead exposure; Other - chemical resistant apron when cleaning equipment mixing and loading	either	either
Prep® (ethephon) EPA Reg. No. 264-418 Aventis Cropscience	Danger	48 hrs.	coveralls over short-sleeved shirt and short pants; waterproof gloves; protective eyewear; chemical resistant footwear plus socks; chemical resistant headgear for overhead exposures; chemical resistant apron when cleaning equipment	coveralls over short-sleeved shirt and short pants; waterproof gloves; protective eyewear; chemical resistant footwear plus socks; chemical resistant headgear for overhead exposures	yes	yes

Worker Protection Standards Tobacco Pesticides

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 Oral	Worker Notification Posted
Prime+® *(Flumetralin)* EPA Reg. No. 100-640 Syngenta Crop Protection	Danger	24 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	either	either
Provado 1.6F ® **(**imidacloprid) EPA Reg. No. 3125-457 Bayer	Caution	12 hrs.	long-sleeved shirt and long pants, waterproof gloves; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either
Prowl® 3.3 (pendimethalin) EPA Reg. No. 241-337 BASF Corp. **Prowl® H20** (pendimethalin) EPA Reg. No. 241-418 BASF Corp. **Pendimax 3.3** EPA Reg. No. 68156-6-62719 Dow AgroSciences LLC	Caution	12 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves; shoes plus socks	coveralls; chemical-resistant gloves; shoes plus socks	either	either
Quadris (azoxystrobin) EPA Reg. No. 100-1098 Syngenta Crop Protection	Caution	4 hrs.	long-sleeved shirt and long pants; chemical-resistant gloves; shoes plus socks	coveralls; chemical-resistant gloves; shoes plus socks	either	either

Worker Protection Standards Tobacco Pesticides

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2] Applicators and Other Handlers	To Enter Treated Area Within REI[3]	Worker Notification Oral	Posted
Ridomil Gold SL ® (mefenoxam) EPA Reg. No. 100-801 Syngenta Crop Protection	Warning	48 hrs.	long-sleeved and long pants, chemical-resistant gloves, shoes plus socks, protective eyewear	coveralls, chemical-resistant gloves, shoes plus socks, protective eyewear	none	none
Royal MH-30® (maleic hydrazide) EPA Reg. No. 400-84 **Royal MH-30® SG** EPA Reg. No. 400-165 **Royal MH-30® XTRA** EPA Reg. No. 400-452 Chemtura	Caution	12 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either
Sevin® 4F (carbaryl) EPA Reg. No. 264-349 **Sevin® XLR Plus** EPA Reg. No. 264-333 Bayer Crop Science	Caution	12 hrs	long-sleeved shirt and long pants; chemical resistant gloves such as Barrier Laminate, butyl rubber, nitrile rubber, neoprene rubber, polyvinyl chloride (PVC), or Viton; shoes plus socks and chemical-resistant headgear for overhead exposure	coveralls; chemical resistant gloves such as Barrier Laminate, butyl rubber, nitrile rubber, neoprene rubber, polyvinyl chloride (PVC), or Viton; shoes plus socks and chemical-resistant headgear for overhead exposure	either	either
Sevin® 80S (carbaryl) EPA Reg. No. 264-314 **Sevin® 80S** Bayer Crop Science	Warning	12 hrs	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks and chemical-resistant headgear for overhead exposure	coveralls; waterproof gloves; shoes plus socks and chemical-resistant headgear for overhead exposure	either	either

Worker Protection Standards Tobacco Pesticides

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 Oral	Worker Notification Posted
Sniper 2F (bifenthrin) EPA Reg. No. 34704-858 Loveland Products, Inc.	Warning	12 hrs.	long-sleeved shirt and long pants, chemical-resistant gloves, such as Barrier Laminate or Nitrile rubber or Vitron and shoes plus socks and protective eyewear	coveralls, chemical-resistant gloves, such as Barrier Laminate or Nitrile rubber or Neoprene rubber or Vitron, and shoes plus socks	either	either
Spartan ® 4F (sulfentrazone) EPA Reg. No. 279-3220 FMC Corp.	Caution	12 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks	coveralls over long-sleeved shirt and long pants; water-proof gloves; shoes plus socks	either	either
Spartan Charge (sulfentrazone + carfentraxone) EPA Reg No. 279-3337 FMC Corporation	Caution	12 hrs.	long-sleeved shirt and long pants; chemical resistant gloves made of waterproof material such as polyethylene or polyvinyl chloride; shoes plus socks	coveralls over long-sleeved shirt and long pants; chemical resistant gloves; shoes plus socks	either	either
Sucker Plucker® (C6 - C12 fatty alcohols) EPA Reg. No. 19713-35 Drexel	Warning	24 hrs.	coveralls over short-sleeved shirt and short pants; waterproof gloves; protective eyewear; chemical resistant footwear plus socks; chemical resistant headgear for overhead exposure; chemical resistant apron when cleaning equipment, mixing or loading	coveralls over short-sleeved shirt and short pants; waterproof gloves; protective eyewear; chemical resistant footwear plus socks; chemical resistant headgear for overhead exposure	either	either

Worker Protection Standards Tobacco Pesticides

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 Oral	Worker Notification Posted
Sucker Stuff® (maleic hydrazide) EPA Reg. No. 19713- **Super Sucker Stuff®** EPA Reg. No. 19713-20 Drexel	Caution	12 hrs.	long-sleeved shirt and long pants; shoes plus socks; waterproof gloves	coveralls; waterproof gloves; shoes plus socks	either	either
Sucker Stuff® 60 WS (maleic hydrazide) EPA Reg. No. 19713-371 Drexel	Caution	12 hrs.	long-sleeved shirt and long pants; shoes plus socks	coveralls; waterproof gloves; shoes plus socks	either	either

Worker Protection Standards Tobacco Pesticides

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

Worker Protection Standards Tobacco Pesticides

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

Worker Protection Standards Tobacco Pesticides

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE)[2] Applicators and Other Handlers	To Enter Treated Area Within REI[3]	Worker Notification Oral	Posted
Terramaster 4EC (etridiazole) EPA Reg. No. 400-422 Chemtura	Danger	12 hrs.	long-sleeved shirt and long pants, shoes plus socks, protective eyewear, dust/mist filtering respirator or a NIOSH approved respirator with any N, R, P, or HE filter	coveralls, waterproof gloves, shoes and socks, protective eyewear	none	none
TMOXX ® 2SC (thiamethoxam) EPA Reg. No. 100-939-51873 Fair Products	Caution	12 hrs.	Long-sleeved shirt, waterproof gloves, shoes plus socks	Coveralls, shirt, waterproof gloves, shoes, plus socks	yes	yes
Tracer® 4 (spinosad) EPA Reg. No. 62719-267 SLN No. VA980001 Dow AgroSciences	Caution	4 hrs.	long-sleeved shirt and long pants; shoes plus socks; waterproof gloves	coveralls; waterproof gloves; shows plus socks	either	either

Worker Protection Standards Tobacco Pesticides

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

Worker Protection Standards Tobacco Pesticides

Product Trade Name (common name) EPA Reg. No. Company Name	Signal Word	Restricted Entry Interval (REI)[1]	Personal Protective Equipment (PPE) [2] Applicators and Other Handlers	To Enter Treated Area Within REI [3]	Worker Notification Oral	Posted
Warrior (lambda-cyhalothrin) EPA Reg. No. 100-1112 Syngenta	Warning	24 hrs.	long-sleeved shirt and long pants, chemical resistant gloves, shoes plus socks, protective eyewear	coveralls, chemical resistant gloves, shoes, plus socks	either	either
XenTari® WDG (*Bacillus thuringiensis*) EPA Reg. No. 275-85 Valent	Caution	4 hrs.	long-sleeved shirt and long pants; waterproof gloves; shoes plus socks; dust/mist filtering respirator (MSHA/NIOSH approved number prefix TC-21C)	coveralls; waterproof gloves; shoes plus socks	either	either

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

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

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