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**1988-89
Pest Management Guide
for
TOBACCO**



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Produced by the Department of Entomology and the Department of Plant Pathology, Physiology and Weed Science, VA Tech. Coordinator: J. M. Luna, Department of Entomology

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Keys to the Proper Use of Pesticides

1. Read the label on each pesticide container before each use. Follow the printed instructions to the letter; heed all cautions and warnings; note precautions about residues.
2. Store pesticides in the containers in which you bought them. Put them where children and animals cannot get to them -- preferably locked-up and away from food, feed, seed and other materials that may become harmful if contaminated.
3. Dispose of empty pesticide containers in the manner specified on their labels.

SEE YOUR DOCTOR IF SYMPTOMS OF ILLNESS OCCUR DURING OR AFTER USE OF PESTICIDES

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Insects on Tobacco

Paul J. Semtner, Extension Entomologist

Tobacco Insect Management

Each year several different insect pests pose a threat to Virginia's tobacco crop. In the past tobacco growers have made several preventive insecticide applications each year to control these pests. In many cases applications were made when insect populations were too low to cause economic damage. Such unnecessary insecticide applications increase production costs, pesticide residues, environmental contamination, and human exposure to pesticides. They also enhance the development of insect resistance to the insecticides, increase the chances that secondary and minor pests will become economic problems and kill predators and parasites which provide considerable natural control.

The integrated pest management (IPM) concept of insect control makes use of natural, cultural, and chemical controls to maintain pest populations below levels that will cause economic damage to the crop. It promotes the timely application of pesticides only when regular field checks indicate that they are needed. This practice will help to preserve the effectiveness of chemicals that are currently labeled for use on tobacco.

The IPM approach to insect control recognizes that a certain amount of insect damage will not reduce tobacco yield or quality enough to pay for the cost of treatment including insecticide, fuel, labor, and equipment. This approach to insect control helps to maximize profits. An important term in IPM is the "treatment threshold." The "treatment threshold" is that pest insect population level that requires control to prevent a reduction in crop value that is greater than the cost of control. Cultural control practices such as early topping in the button or prebutton stage, good chemical sucker control, using recommended rates of nitrogen, adjustments in transplanting dates, and stalk cutting and root destruction soon after harvest will help reduce feeding and overwintering sites for several tobacco insects. Natural control can be promoted by delaying insecticide applications until an insect reaches its "treatment threshold" and by using the insecticides that are least harmful to beneficial insects. Insecticides that have low toxicity to insect predators and parasites of the budworm and hornworm include: Dipel, Dylox/Proxol, and Lannate. Chemicals that are highly toxic to beneficial insects include: Azodrin, Guthion, malathion, parathion, and Supracide.

Scouting Tobacco Fields for Insects

Tobacco fields should be scouted at least once a week to determine the abundance of insect pests. Accurate samples are essential for determining the proper timing of insecticide applications. They should consist of observations on insects and insect damage on at least 50 plants in each field. Count insect pests on 5 consecutive plants at each of 10 different locations in the field. Large fields will require larger samples. Do not take more than 20% of the sample along field margins. All insect counts should be recorded in a common notebook and retained for later reference. After counts are made the results should be compared to the threshold levels mentioned later in this publication. If pest populations meet or exceed the threshold levels, labeled insecticides should be applied for their control.

Hornworms, budworms, flea beetles, and green peach aphids are the most important insect pests that feed on tobacco foliage in Virginia. Therefore, they are the primary targets of a tobacco scouting program. Plants should be examined for insects, insect damage and insect droppings. First, look for insect damage and then locate the pest; check the bud region and upper one-third of the plant for aphids, budworms and hornworms. Count the insect pests present in this region, and check for the cocoons of beneficial insects such as the budworm parasite, *Camponotus sonorensis*, and the hornworm parasite, *Cotesia congregata*. The undersides of lower-, mid-, and upper-stalk tobacco leaves should be checked for aphids, honeydew, flea beetles and flea beetle feeding holes. If an unidentified insect is observed and it appears to be causing serious damage to the crop, the insect and samples of its damage should be collected and taken to a local County Extension Agent for assistance in identification. This is important because untrained persons sometimes mistake beneficial insects for pests or misidentification of a pest may result in the selection of the wrong insecticide for its control. Tobacco fields should be treated when one or more insect pests meet or exceed the treatment threshold levels described below.

Wireworms

In recent years, wireworms have increased in importance as pests of tobacco in Virginia. Wireworms, the larval stage of the click beetle, are hard, yellowish-brown grubs that tunnel the roots and piths of newly-transplanted tobacco during the first month after transplanting. Their injury stunts plants, causes irregular growth and can reduce yields. The life-cycle of wireworms takes about a year to complete. The larvae, which live in the soil, emerge from the eggs in late summer and fall and overwinter into the following season. Wireworms are most common in tobacco fields with a past history of wireworms, or those planted previously in sod, weeds or small grains. In these situations, the use of a soil insecticide is suggested for wireworm control. Treatments should be broadcasted and incorporated by double disking at least 2 weeks before transplanting. Plowing fields in early spring will also help reduce wireworm problems. Sturdy, healthy transplants should be used since they are less susceptible to wireworm damage than tender transplants.

Tobacco Budworm

Tobacco budworm larvae feed in the buds of young tobacco plants causing many holes in the tiny developing leaves. As these leaves increase in size, the feeding holes increase proportionally. Giving the leaves a ragged, distorted appearance. Tobacco plants are sometimes topped by budworms resulting in early sucker growth which can cause stunting and will require extra labor for proper crop management. Tobacco budworm control should be initiated anytime prior to buttoning when 10% of the plants have living budworms. Apply foliar sprays for budworm control with 1 or 3 full-cone or hollow-cone nozzles over each row using 40 to 60 pounds pressure to deliver 10 to 25 gallons of spray mixture per acre. Control with foliar sprays rarely exceeds 80 percent. However, Bacillus thuringiensis (Dipel) baits applied by hand usually gives better than 90% control. When tobacco is checked for budworms, the cocoons of a wasp (Campoletis) that parasitizes budworms will also be observed, attached to the leaves near the bud. These cocoons are about 1/4 inch long and white or grayish in color with two black bands. Many producers mistake these for the cocoons of the budworm, which are reddish-brown, about 3/4 inch long, and are formed in the soil beneath the plant. Plants with Campoletis cocoons in the bud region rarely have living budworms. Campoletis often provides good natural control of budworms in Virginia and should be promoted as much as possible.

Hornworms

The tobacco hornworm and the tomato hornworm are large caterpillars that consume considerable amounts of tobacco leaf. Infestations may develop anytime from transplanting until harvest, but the most severe damage occurs during mid- to late-June and August. Control should be initiated when 10% of the plants have hornworms an inch or more in length. A hornworm with white egg-like cocoons of the parasitic wasp, Cotesia congregata, on its back eats much less than a healthy hornworm and it provides a source of parasites that will help reduce the following generation of hornworms. Therefore, parasitized hornworms should not be counted when determining the treatment threshold level. For best hornworm control, insecticide sprays should be directed to the upper one-third of the plant.

Green Peach Aphid

The green peach aphid has been a severe pest of tobacco in Virginia for the past decade. It may infest tobacco plant beds, but the most severe damage occurs on field tobacco from late June to August. Aphids can be introduced into the field on infested tobacco transplants, but immigration of winged aphids that deposit young wingless aphids on tobacco plants is the most important means of infestation. High aphid populations can reduce tobacco yield by 5 to 25% under some growing conditions. Aphids deposit honeydew on tobacco leaves and a dark, sooty mold often develops. This interferes with curing and reduces quality. The presence of sooty mold indicates that aphids have been a problem, but it does not necessarily indicate that treatable populations of aphids are present on the tobacco at the time of observation.

A red form of the green peach aphid has been common on tobacco in Virginia in 1986 and 1987. In laboratory studies the red form reproduced more quickly and was more tolerant of higher temperatures than the green form. If you have trouble controlling aphids contact your Extension Agent to see if more current information is available for its control.

From mid-June to the end of August, producers should watch for increases in aphid densities. The undersides of leaves from the lower, middle, and upper portions of tobacco plants should be examined at regular intervals to determine the extent of aphid population buildup. Producers should also be on the lookout for a layer of honeydew that gives the lower tobacco leaves a shiny appearance and indicates that there may be an aphid problem. Treatments should be initiated for aphid control when 20% of the plants are infested with about 50 aphids per upper leaf. Most insecticides applied to the foliage have to come in contact with the aphids to provide adequate control. Aphids are often more severe in partially shaded areas along the edge of fields. Treatment of these areas is sometimes sufficient for reducing aphid damage in a field.

Tobacco Flea Beetle

Adult tobacco flea beetles feed on the leaves and stalks of tobacco in the plant bed and in the field, while the grubs or larvae feed on tobacco roots. Heavy feeding by both beetle stages on newly set transplants may cause stunting of scattered plants in the field, resulting in uneven stands. When checking tobacco fields for flea beetles, look for the feeding damage which gives the lower leaves a shot-hole appearance and then count the beetles on 20 plants (2 per field-sample location). Treatment for tobacco flea beetle control should be initiated on newly set tobacco when there are 4 beetles or more per plant. Larger plants can tolerate very high flea beetle densities but applications should be made when densities exceed 40 beetles per plant.

Application Methods

Insecticides must be applied properly for maximum insect control. On small tobacco, good control can be obtained using a single solid-cone or hollow-cone nozzle per row directed to the bud. Operate equipment at 40 to 60 pounds pressure, do not exceed 4 1/2 miles per hour, and use at least 6 to 8 gallons of mixed spray per acre. After tobacco is 2 ft. tall, use one or three cone nozzles per row. If three nozzles are used, the two side nozzles should be oriented at a 45 degree angle toward the upper 1/3 of the plant. Use 40 to 60 pounds pressure and 18 to 25 gallons of spray mixture per acre. Set the nozzles 12 to 18 inches above the tobacco. Drop nozzles oriented to the underside of the leaves may improve control. Drop nozzles should be used in combination with 1 to 3 nozzles over the row. Set up the nozzles on metal, plastic, or rubber tubing that is 2 to 4 ft. long and extends down between the tobacco rows from the sprayer boom. The nozzles that are placed on the drop tubes should be oriented slightly upward for proper spray distribution.

Soil Incorporated Insecticides

Pretransplant applications of insecticides are often used for the control of wireworms, flea beetles, aphids, cutworms, and hornworms on tobacco. Some of these insecticides are also nematicides. Pretransplant applications of insecticides are often unnecessary since the timely use of foliar insecticides also provides effective control of tobacco insects at a lower cost.

Several things should be considered before selecting a soil insecticide. First, determine whether there is a nematode problem in the field. This can be done by taking a predictive nematode sample in the fall and asking your Extension agent to send the sample to the Virginia Tech Nematode Assay Laboratory. The recommended control guidelines listed on the report that is returned should be followed to select an appropriate nematicide. Mocap, Dasanit, Furadan, and Vydate control both insects and nematodes. Secondly, if tobacco is to be planted in land that has been in sod, weeds or small grain the previous year or has a history of wireworm problems, an insecticide should be applied for wireworm control. Several chemicals have different labeled rates for wireworm and nematode control. Nematicur, the most effective contact nematicide, is not effective against wireworms. Therefore, another chemical may be needed for wireworm control. Cutworm problems are fairly difficult to predict. However, plowing fields in the early spring will help reduce cutworm populations. In fields plowed late, potential cutworm problems may be predicted by placing clumps of green clover at various locations throughout the field. If large numbers of cutworms are observed under the clumps after 3 to 7 days, a pretransplant treatment for cutworm control is recommended. Otherwise, the frequent examination of fields for cutworm injury during the first 2 weeks after transplanting will help warn the grower when a foliar treatment is needed for their control.

Three systemic soil insecticides, Di-Syston (also in Mocap Plus), Temik and Furadan provide control of a variety of insect pests feeding on tobacco foliage. Di-Syston 15G will usually provide some early-season aphid control but treatment with a foliar insecticide may still be necessary. Temik has provided good aphid control. Furadan usually gives good control of flea beetles and hornworms. However, under some effective conditions, it fails to control these insects. Several foliar insecticides and transplant water treatments provide effective alternatives to the use of Furadan. Orthene and Vydate applied in the transplant water provide good early-season (2- to 4-week) control of flea beetles during the period when they can do the most damage.

Precautions

Many of the insecticides used on tobacco are extremely poisonous. Always read the label before mixing or applying pesticides. See the list of precautions for pesticide use following the tobacco insect control recommendations.

Plant Bed Insects

Insect	Insecticide and Formulation	Rate Per 100 Sq Yds	Re-entry Time ¹ (Days)	Remarks and Precautions
<i>Cutworms</i>	Acephate (Orthene Tobacco Insect Spray) 75SP	4 tsp in 3 to 6 gal of water (1 lb/acre)	--	Make spray applications to plant beds and adjacent alleys during late afternoon.
	Carbaryl (Sevin) 5% bait.	1/2 to 1 lb	--	Do not apply directly to plants. May be phytotoxic.
	Trichlorfon (Dylox/Proxol) 5% Commercial or Homemade Bait	6 to 7 oz	--	Use clean gloves to apply trichlorfon bait. Scatter bait around margins of bed and in open spaces in the late afternoon. Prepare bait by mixing 3 3/4 lb of wheat bran and 1/4 lb of Dylox or Proxol 80SP.
<i>Green June beetle larvae</i>	Diazinon 50WP	1/2 lb in 100 gal of water	--	Treat only affected areas. Apply as a drench using a sprinkler can. Methyl bromide, when applied prior to seeding for weed control, will kill grubs present.
	Trichlorfon (Dylox/Proxol) 80SP	10 oz in 100 gal of water	--	
<i>Aphids, Flea beetles</i>	Acephate (Orthene Tobacco Insect Spray) 75SP	4 tsp in 3 to 6 gal water (1 lb/acre)	*	Spray plants as needed. Do not pull plants until spray deposit has dried. Carbaryl (Sevin) should not be used for flea beetle control in plant bed because it may harm young plants.
<i>Aphids, Flea beetles (preventive control)</i>	Disulfoton (Di-Syston) 15G	9 oz	--	Broadcast granules evenly over plant bed just before seeding or after plants have emerged and are 1/2 to 1 inch in diameter. Rake in pre-seeding treatment or water thoroughly and do not apply to plant bed more than once per season. Disulfoton is very poisonous.
<i>Aphids, grasshoppers</i>	Malathion 4D or 5D	10 oz	--	Plants should be free of aphids before transplanting. Turnips, mustard, and dock (winter hosts of aphids) should be eliminated from the vicinity of plant bed.
	Malathion 25WP	1 lb in 50 gal of water or 1 tbsp per gal of water, 3 to 6 gal	--	
<i>Snails and slugs</i>	Hydrated or air slacked lime	4 lbs	--	Lime dust applied in a band 3 to 4 inches wide along the margin of the bed may act as a barrier.
	Metaldehyde bait	Follow label.	--	Apply to the soil surface in alleys and vacant areas in the plant bed in late afternoon. Do not apply directly on the foliage.

*Do not re-enter plant bed until spray deposit has dried.

¹Minimum time interval between application and worker re-entry into field.

Insects on Field Tobacco - Pretransplant Soil Treatments

Insect	Insecticide and Formulation	Rate Per Acre	Waiting Periods		Remarks and Precautions
			Re-Entry Time ¹ (Days)	Application to Harvest (Days)	
<i>Aphids</i> (Early season suppression of <i>flea beetles</i>)	Aldicarb (Temik) 15G (Flue-Cured Only)	7 to 14 lb	--		Apply granules in a 6 to 12 inch band and incorporate into soil or cover with soil to a depth of 2 to 6 inches when forming beds. Transplant into treated area. A 20 lb/acre rate is labeled for nematodes and also provides good aphid control. Do not apply more than one week before transplanting. Aldicarb is extremely poisonous.
<i>Aphids, Flea beetles</i> (preventive control)	Disulfoton (Di-Syston) 15G	13.3 to 26.7 lb	--	**	Broadcast and disk into the soil immediately to a depth of 4 in, 2 days to 2 weeks before transplanting or apply in a 6- to 12- inch band on top of the row before transplanting and incorporate to a depth of 4 in Do not apply more than once per season regardless of formulation used. Disulfoton is also available in combination with ethoprop (Mocap Plus) and fensulfthion (Dasanit-Di-Syston). Supplemental aphid control may be required when Disulfoton is used. Disulfoton is extremely poisonous.
<i>Flea beetles</i> (preventive control)	Disulfoton (Di-Syston) 8 LC	2 qts		**	
<i>Flea beetles</i>	Carbofuran (Furadan) 15G	26.7 to 40 lb flue-cured and 20 to 26.7 lb burley	--	**	Preplant broadcast soil application method is same as above for Di-Syston. Overlapping and excessive rates may cause flecking of lower leaves and yield reductions. To reduce the possibility of plant injury, allow 14 days between application and transplanting. Carbofuran is highly poisonous. Respirators goggles, and protective clothing should be worn by persons mixing, applying and incorporating carbofuran 4F.
	Carbofuran (Furadan) 4F	1 gal per acre (flue-cured and fire-cured tobacco only)	--	**	

* Do not re-enter plant bed until spray deposit has dried.
 ** Non applicable.

¹ Minimum time interval between application and worker re-entry into field.

Insects on Field Tobacco - Pretransplant Soil Treatments

Insect	Insecticide and Formulation	Rate Per Acre	Waiting Periods		Remarks and Precautions
			Re-Entry Time ¹ (Days)	Application to Harvest (Days)	
<i>Hornworms</i> (Early-season control only)	Carbofuran (Furadan) 15G	26.7 to 40 lb flue-cured and 20 to 26.7 lb burley	--	**	
	Carbofuran (Furadan) 4F	1 to 1 1/2 gal	--	**	
Broadcast Treatments					
<i>Wireworms</i>	Carbofuran (Furadan) 4F (Flue-cured and dark-fired tobacco only)	1 to 1/2 gal	--	**	Make broadcast application at least 2 weeks before transplanting (3 to 4 weeks for diazinon). Use a low-gallonage boom sprayer (weed control type) to apply liquids or a calibrated granular applicator, grain drill or fertilizer spreader to apply granules. Band applications are usually less effective than broadcast treatments. Do not mix granules with fertilizer or other materials. Double disk insecticides into soil immediately after application to a depth of at least 4 inches for carbofuran, fonophos, chlorpyrifos, fensulfothion and ethoprop and 6 to 9 inches for diazinon. Fensulfothion and ethoprop are available in combination with disulfoton (Di-Syston).
	Carbofuran (Furadan) 15G (Flue-cured tobacco only)	26.7 to 40 lb	--	**	
	Diazinon (AG 500) 4EC	2 qt	--	**	
	Diazinon 14G	14 to 21 lb	--	**	
	Diazinon 50WP	4 to 6 lb	--	**	
	Ethoprop (Mocap) 6EC	1 gal	--	**	
	Ethoprop (Mocap) 10G	20 lb	--	**	
	Fensulfothion (Dasanit) 6EC	2 2/3 pt	--	**	
	Fensulfothion (Dasanit) 15G	13.3 lb	--	**	
<i>Wireworms, cutworms</i>	Fonophos (Dyfonate) 10G	10 to 20 lb	--	**	
	Chlorpyrifos (Lorsban) 15G	13.5 to 20 lb	--	**	
	Chlorpyrifos (Lorsban) 4E	2 to 3 qt	--	**	
Transplant Water Treatments					
<i>Flea beetles</i>	Acephate (Orthene Tobacco Insect Spray) 75SP	1 lb	--	--	Apply in at least 100 gal of water per acre. Provides control for 3 to 4 weeks after transplanting. Allow tank to run low before refilling.

* Do not re-enter plant bed until spray deposit has dried.
 ** Non applicable.

¹ Minimum time interval between application and worker re-entry into field.

Insects on Field Tobacco - Preplant and Foliar Treatments

Insect	Insecticide and Formulation	Rate Per Acre	Waiting Periods		Remarks and Precautions
			Re-Entry Time ¹ (Days)	Application to Harvest (Days)	
Flea beetles (cont'd)	Oxamyl (Vydate) 2L	1 pt	--	**	Vydate when applied at 1 1/4 to 2 pts/acre in transplant water also acts as a nematicide. Calibrate transplanters and allow tank to run low before refilling as over-applications may cause stunting of tobacco.
Wireworms	Diazinon 50 WP	6 oz per 200	--	**	At least 200 gal of water per acre is recommended for hand transplanters and more for mechanical transplanters.

Foliar Treatments

Budworms	Acephate (Orthene Tobacco Insect Spray) 75%SP	1 lb or 2 tbsp per gal of water	*	3	Apply as a spray. When using hand sprayer apply in 25 gal per acre.
	Bacillus thuringiensis (Dipel 2X) (Dipel 4L)	1/4 to 1/2 lb 1 pt	0	0	Apply as a spray. Do not allow diluted sprays to stand more than 12 hours.
	Bacillus thuringiensis (Dipel 1% homemade bait) Dipel 10G	15 to 25 lb 10 lbs	0	0	Prepare bait by mixing 1 lb of Bacillus thuringiensis with 99 lbs of cornmeal. Apply bait overtop each row using duster or by gloved hand.
	Carbaryl (Sevin) 80WP	1 1/4 to 2 1/2 lb	*	3	Apply as a spray. Do not apply until plants are established and growing.
	Carbaryl (Sevin) 50WP	2 to 4 lb	*	3	The green peach aphid often becomes a problem on tobacco following two or more applications of carbaryl.
	Carbaryl (Sevimol) 4F	1 to 2 qt	*	3	
	Endosulfan (Thiodan) 4D	15 to 24 1/2 lb	1	5	Apply dust to bud and top leaves of each plant using a hand duster. Avoid heavy applications with cloth bags because plant injury may result.
	Endosulfan (Thiodan) 3EC	2/3 to 1 1/3 qt	1	5	Apply as a spray. <u>Very toxic.</u>
	Methidathion (Supracide) 2E	2 qt	1	3	Apply as a spray in at least 25 gal water per acre. Do not apply with other pesticides.

* Do not re-enter plant bed until spray deposit has dried.

** Not applicable.

¹ Minimum time interval between application and worker re-entry into field.

Insects on Field Tobacco

Insect	Insecticide and Formulation	Rate Per Acre	Waiting Periods		Remarks and Precautions
			Re-Entry Time ¹ (Days)	Application to Harvest (Days)	
<i>Budworm</i> (cont'd)	Methomyl (Lannate/Nudrin) 90SP	1/2 lb	1	5 flue-cured 14 fire- and air-cured	Apply as a spray. Make applications as needed. Direct the spray into the buds before buttoning. <u>Methomyl is very poisonous.</u>
	Methomyl (Lannate/Nudrin) 1.8EC	1 qt			
	Methyl Parathion (Pennacap-M) 2FM	2 to 3 qt	1	5	Apply as a spray. Avoid contact with plant juices when priming or cutting tobacco.
	Monocrotophos (Azodrin) 5WM	1 to 1 5/8 pt	2	5	Monocrotophos will kill birds and other wildlife. Do not apply when weather conditions favor drift from area treated. <u>Monocrotophos is very toxic.</u>
<i>Cabbage looper</i>	Acephate (Orthene Tobacco Insect Spray) 75SP	1 lb or 2 tbs per gal	*	3	Apply as a spray in 10 to 50 gal of water
	<u>Bacillus thuringiensis</u> (Dipel 2X)	1/4 to 1/2 lb	0	0	Apply as a spray. Do not allow dilute sprays to stand in tank more than 12 hrs
	Dipel 4L	1 pt	0	0	
	Methomyl (Lannate/Nudrin) 90SP	1/2 lb	1	5 flue-cured 14 fire- and air-cured	Apply as a spray. <u>Methomyl is very toxic.</u>
Methomyl (Lannate/Nudrin) 1.8EC	1 qt				
<i>Cutworms</i>	Acephate (Orthene Tobacco Insect Spray) 75SP	1 lb	*	3	Apply as a spray overtop of plants in affected areas when 2% of plants are injured by cutworms. Make application during late afternoon using at least 25 gal of spray per acre.
	Trichlorfon (Proxol) 80SP	1 1/4 lb	*	3	
	Trichlorfon (Dylox/Proxol) 5% Commercial or Homemade Bait	20 lb	--	--	Use clean gloves to apply trichlorfon bait. Apply during late afternoon to infested areas of field when more than 2% of plants are damaged by cutworms. Prepare a homemade bait by mixing 1 1/4 lb of trichlorfon 80SP with 18 3/4 lb of cornmeal.

* Do not re-enter plant bed until spray deposit has dried.

¹ Minimum time interval between application and worker re-entry into field.

Insects on Field Tobacco

Insect	Insecticide and Formulation	Rate Per Acre	Waiting Periods		Remarks and Precautions
			Re-Entry Time ¹ (Days)	Application to Harvest (Days)	
Grasshoppers	Acephate (Tobacco Insect Spray) 75SP	1/3 to 2/3 lb	*	3	Apply as a spray. Treat crop and a strip around field to reduce grasshopper immigration. Avoid contact with plant juices when priming or cutting tobacco treated with methyl parathion.
	Methyl Parathion (Pennacap M) 2FM	1 to 3 pt	1	5	
	Sevin 80WP	2/3 to 1 7/8 lb	*	3	
Aphids	Acephate (Orthene Tobacco Insect Spray) 75SP	2/3 lb or 4 tsp per gal	*	3	Apply as a spray. Use drop nozzles to orient spray to undersides of leaves. Aphids fly to tobacco fields and may go unnoticed until plants become heavily infested. Spot treatment of localized infestations is beneficial and may prevent need to treat entire field.
	Diazinon (AG 500) 4EC	3/4 pt in water or 1 tbsp per gal of water	*	3	
	Endosulfan (Thiodan) 4D	15 to 24 1/4 lb	1	5	
	Endosulfan (Thiodan) 3EC	2/3 to 1 1/3 qt	1	5	
	Malathion 4EC or 5EC	1 1/2 to 2 1/2 pt or 2 to 3 tbsp per gal of water	*	7	
	Malathion 4 or 5D	25 to 30 lb	*	7	
	Methomyl (Lannate/Nudrin) 90SP	1/4 to 1/2 lb	1	5 flue-cured 14 fire- and air-cured	
	Methomyl (Lannate/Nudrin) 1.8EC	1 qt			
Methyl Parathion (Pennacap M) 2FM	1 to 2 qt	1	5	Apply as a spray in 25 to 40 gal of water.	

* Do not re-enter field until deposit has dried.

¹ Minimum time interval between application and worker re-entry into field.

Insects on Field Tobacco

Insect	Insecticide and Formulation	Rate Per Acre	Waiting Periods		Remarks and Precautions
			Re-Entry Time ¹ (Days)	Application to Harvest (Days)	
<i>Aphids</i> (cont'd)	Monocrotophos (Azodrin) 5WM	7/8 pt or 14 oz	2	5	Monocrotophos will kill birds and other wildlife. Do not apply when weather conditions favor drift from treated area. <u>Monocrotophos is highly poisonous.</u>
<i>Hornworms</i>	Acephate (Orthene Tobacco Insect Spray) 75SP	2/3 lb in water or 4 tsp per gal of water	*	3	Apply as a spray. Treat infested fields before worms exceed 1 1/2 inches in length. Insecticides should be directed toward top six leaves of plants. Prime before treatment.
	Azinphosmethyl (Guthion) 2EC	1 qt	1	6	<u>Azinphosmethyl is highly poisonous.</u>
	Azinphosmethyl (Guthion) 50WP	1 to 1 1/4 lb	1	6	
	Bacillus thuringiensis (Dipel/2X) Dipel 4L	1/3 to 1/4 lb 1/2 to 1 pt	0 0	0 0	Apply as a spray. Do not allow dilute sprays to stand in tank more than 12 hr. Dipel can be tank-mixed with maleic hydrazide (MH-30).
	Carbaryl (Sevin) 80WP	1 1/4 lb in 25 gal of water or 3 tbsp per gal of water	*	3	Apply as a spray.
	Carbaryl (Sevimol) 4F	1 to 2 qt	*	3	
	Endosulfan (Thiodan) 3EC	2/3 to 1 1/3 qt	1	5	
	Endosulfan (Thiodan) 4D	15 to 24 1/4 lb	1	5	Apply as a dust.
	Methidathion (Supracide) 2EC	1 to 1 1/2 qt	1	3	Apply as a spray in at least 25 gal of water per acre. Do not mix with other pesticides.
	Methomyl (Lannate/Nudrin) 90SP	1/4 to 1/2 lb in 25 gal of water	1	5 flue-cured 14 fire- and air-cured	Apply as a spray. Methomyl is very poisonous.
	Methomyl (Lannate/Nudrin) 1.8EC	1 to 2 pts			
Methyl Parathion (Pennacap M) 2FM	2 to 3 qts	2	5	Apply as a spray. Avoid contact with plant juices when priming or cutting tobacco.	

* Do not re enter field until deposit has dried.

¹ Minimum time interval between application and worker re-entry into field.

Insects on Field Tobacco

Insect	Insecticide and Formulation	Rate Per Acre	Waiting Periods		Remarks and Precautions
			Re-Entry Time ¹ (Days)	Application to Harvest (Days)	
Hornworms (cont'd)	Monocrotophos (Azodrin) 5WM	7/8 pt or 14 oz	2	5	Monocrotophos will kill birds and other wildlife. Keep out of any body of water. Do not apply when weather conditions favor drift from area treated. <u>Monocrotophos is very toxic.</u>
	Trichlorfon (Dylox/Proxol) 80SP	1 1/4 lb	*	3	
Japanese beetles	Carbaryl (Sevin) 80WP	1 1/4 lb or 3 tbsp per gal of water	*	3	Apply as a spray.
Stink bugs	Endosulfan (Thiodan) 4D	15 to 24 1/4 lb	1	5	Apply as a dust.
	Endosulfan (Thiodan) 3EC	2/3 qt	1	5	Apply as a spray.
Flea beetles	Acephate (Orthene Tobacco Insect Spray) 75SP	2/3 lb or 4 tsp per gal of water	*	3	
	Azinphosmethyl (Guthion) 2EC	1 qt	1	6	Apply as a spray. Prime before treating. <u>Azinphosmethyl is very toxic.</u>
	Azinphosmethyl (Guthion) 50WP	1 to 1 1/2 lb	1	6	
	Carbaryl (Sevin) 80WP	1 1/4 lb or 3 tbsp per gal of water	0	3	Apply as a spray. Do not apply until plants are established and growing. Green peach aphid often becomes a problem on tobacco following two or more applications of carbaryl.
	Endosulfan (Thiodan) 3EC	2/3 to 1 1/3 qts	1	5	Apply as a spray.
	Endosulfan (Thiodan) 4D	15 to 24 1/4 lbs	1	5	Apply as a dust.
	Methidathion (Supracide) 2EC	1 to 1 1/2 qt	2	3	Apply as a spray in at least 25 gal of water per acre. Do not apply with other pesticides.
	Methomyl (Lannate/Nudrin) 90SP	1/4 to 1/2 lb	1	5 flue-cured, 14 fire- and air-cured	Apply as a spray. <u>Methomyl is very poisonous.</u>
	Methomyl (Lannate/Nudrin) 1.8EC	1 to 2 pt			
	Methyl parathion (PennCap M) 2FM	2 to 3 qt	1	5	Apply as a spray. Avoid contact with plant juices when priming or cutting tobacco.

* Do not re enter field until deposit has dried.

¹ Minimum time interval between application and worker re entry into field.

Insects on Field Tobacco

Insect	Insecticide and Formulation	Rate Per Acre	Waiting Periods		Remarks and Precautions
			Re-Entry Time ¹ (Days)	Application to Harvest (Days)	
<i>Flea beetles</i> (cont'd)	Monocrotophos (Azodrin) 5WM	7/8 pt or 14 oz	2	5	Monocrotophos will kill birds and other wildlife. Keep out of any body of water. Do not apply when weather conditions favor drift from treated area. <u>Monocrotophos is very toxic.</u>

Insects on Stored Tobacco

Insect	Control	Remarks
<i>Tobacco moths and cigarette beetles</i>	Sanitation	Keep tobacco barns and packhouse free of tobacco debris and keep as dark as possible. Do not store tobacco near feed grain or seed. Do not store tobacco infested with tobacco moth or cigarette beetle. Sell all tobacco as soon as possible.
<i>Tobacco moths</i>	<i>Bacillus thuringiensis</i> (Dipel 2X) WP 2 1/2 tsp per qt of water per 100 lb of tobacco	Apply as a fine mist. Spray loose leaves as tobacco is being bundled from curing barn. Tobacco in storage: At first signs of infestation, open bundles and spray loose leaves as tobacco is being rebundled. For tobacco on sticks, treat both sides of leaves as sticks are restacked. Avoid using too much water.

*Do not re enter field until deposit has dried.

¹Minimum time interval between application and worker re entry into field.

Insects on Stored Tobacco

Two insects, the tobacco moth and the cigarette beetle, commonly attack tobacco stored on farm. Of these the tobacco moth is most serious. The larvae, which cause all of the damage, are pinkish to yellow to off white caterpillars about 1/2 inch long. They burrow into and eat ragged holes in cured leaves. Entire leaves may be consumed except for the midrib and large veins. Larvae also deposit webbing and fecal pellets on infested tobacco. The adult tobacco moth is a small gray moth about 3/8 inch long with a 5/8 inch wingspread.

Adult cigarette beetles are light to dark brown, hump backed insects about 1/8 inch long. Adults leave tiny holes as they emerge from pupae cases within tobacco. The hairy C-shaped larvae are whitish with brown heads and are about 1/5 inch long. They cause most of the damage.

The tobacco moth and cigarette beetle are most active from May through November. Cool weather between November and April does not favor their development and extreme cold (less than 32 degrees F) can kill many overwintering larvae, especially those of the cigarette beetle.

Control: Sanitation is the most important method used to control cigarette beetles and tobacco moths on farm. Before a building is used to store tobacco, it should be thoroughly cleaned. This includes the removal of tobacco scraps and dust, feed, seed and other plant and animal products that provide an initial source of infestation. Special attention should be paid to removal of these materials from walls, ceilings, cracks and crevices. The application of Dipel at 3 tsp/1/2 gal water/1000 sq. ft. of surface will control tobacco moths breeding in hard to reach areas.

Tobacco should be stored off the floor on pallets and covered with a plastic sheet to keep it cool and dry and to help exclude insects. Promote good ventilation of the storage building. Cold temperatures in winter kills most cigarette beetles and some tobacco moths.

Stored tobacco should be checked for insects every 2 to 4 weeks from May through October. If the tobacco moth caterpillar, its webbing and feces are found, remove the infested tobacco from the pile, repack and treat the remaining tobacco with Dipel to prevent reinfestation. If the cigarette beetle adult or its C shaped, hairy larvae are found, infested tobacco should be removed.

Fumigants should not be used on tobacco stored on farm because of potential serious safety problems and residues that cause off flavor in the cured product.

Special Precautions

1. Aldicarb, azinphosmethyl, disulfoton, fensulfothion, ethoprop, fonophos, monocrotophos, methomyl, oxamyl and carbofuran are extremely poisonous and may be fatal if swallowed, inhaled or absorbed through the skin. Reduce the possibilities of skin exposure by wearing recommended protective clothing and equipment. Wear goggles and a respirator that has been tested by the National Institute of Occupational Health and Safety (NIOSH) and found to be satisfactory for protection against the insecticides being used. If sickness occurs during or after using these insecticides, call your doctor immediately.
2. Azinphosmethyl, Penncap M, monocrotophos, malathion, endosulfan, and diazinon are highly toxic to bees exposed to direct treatment or to residues on crops.
3. Carbaryl, methomyl, acephate, trichlorfon, methidathion, and endosulfan, are highly toxic to bees and should not be applied when bees are actively visiting the area.
4. Avoid excessive use of insecticides on tobacco. Do a thorough job of treating and repeat only when field scouting indicates that insect populations are at or above the economic threshold.

DO NOT USE ENDRIN, ALDRIN, HEPTACHLOR, TOXAPHENE, CHLORDANE, LINDANE, BHC, DDT, TDE, DIELDRIN, OR LEAD ARSENATE ON THE FOLIAGE OF GROWING TOBACCO PLANTS.

Diseases of Tobacco

C. S. Johnson, Extension Plant Pathologist, Tobacco

Control of diseases that attack tobacco involves the careful selection of one or more control practices for the disease situation for each field. Prevention of diseases before they occur can save money and stabilize production.

Tobacco Disease Diagnosis and Control Services - Proper control of tobacco diseases depends on proper identification of the cause of the problem. Disease counts and nematode assays should be done late in the season for each field. Recording the distribution of diseased plants this year can help prevent losses from the same disease in future years. Application of chemical soil treatments can be beneficial in fields with disease problems, but, chemical soil treatments may not be needed where disease or nematode levels are very low. Decisions regarding whether or not to use a chemical soil treatment or which of the different materials to select, should be based on disease level, other control practices, and cropping plan. The selection of proper control practices should be based on the disease situation and cropping sequences for each field. Your local Cooperative Extension Service office will aid you in the identification of the tobacco problem and provide control recommendations.

Disease Management Practices

Early Stalk and Root Destruction - This practice aids in the reduction of disease, insect and weed infestation levels that will carry over into future tobacco crops. Stated simply, the longer the roots and stalks remain alive, the larger the pest infestation levels that will carry over into future crops. Research has proven an increase in yields from using the early stalk and root destruction program. This program contributes to the effectiveness of other control methods including resistant varieties, crop rotation and chemical control.

The pests controlled and the procedure to be followed differ slightly for each tobacco type. The pests reduced for each tobacco type are as follows: 1) Burley - blue mold, black root rot, aphid-borne viruses (etch, vein mottling, etc.), black shank, nematodes, hornworms, budworms, flea beetles and weeds; 2) dark-fired - same as above including tobacco mosaic virus, and brown spot; 3) sun-cured - same as above; and 4) flue-cured - same as above including Potato virus Y (vein banding), and Granville wilt.

The following steps should be completed to gain maximum benefit from this practice: 1) flue-cured - cut stalks into small pieces with bushhog or similar equipment the day that harvest is complete for each field; 2) All types - disl or plow-out roots the day the harvest is completed. Roots must be exposed to air for about 2 weeks to obtain maximum drying of roots; 3) after 2 weeks, re-disc field to provide additional root kill and to bury crop refuse; 4) plant a cover crop when root systems are killed and plant debris is buried. All tobacco growers must use the early stalk and root destruction practice to obtain area wide benefit.

Rotation - Crop rotation helps reduce the effects of diseases such as black shank, Granville wilt, root knot and cyst nematodes, mosaic, and black root rot. The use of the proper rotation crop for each disease is important in reducing the infestation level of the pest. Tobacco following tobacco should be avoided. Under this situation, diseases may cause losses even if other control measures are used.

Disease Resistant Varieties - Disease resistant varieties offer good control of several of the major diseases of tobacco. However, growers should consider the major disease problem and the level of infestation when selecting a resistant variety. resistant varieties should also be used in conjunction with rotation disease control chemicals.

Diseases

Blue Mold - The Virginia tobacco producer should consider blue mold an annual threat and continue to use proper control practices. Although there have been reports of Ridomil resistant strains of blue mold from Central America, Ridomil continues to control blue mold in the United States. There is no need at this time to discontinue the use of Ridomil to control blue mold because of these reports.

Blue mold is favored by cool-wet weather, but limited infection and disease development can still occur during hot weather. All tobacco producers are strongly urged to use control practices that would prevent the occurrence of blue mold in the plant bed and field. This disease has the potential each year to cause serious losses and should not be approached with a "wait and see" attitude before application of control measures.

The following control measures are suggested for blue mold:

- I. Plant Bed.
 - a. Fall fumigation.
 - b. Use fungicides at recommended rates and application procedures.
 - c. Destroy plants after transplanting has been completed.
- II. Field.
 - a. Early stalk and root destruction.
 - b. Use a fungicide at recommended rates and application procedures.
 - c. If possible, avoid fields which favor blue mold development.
 - d. Irrigate early enough in the day that leaves can dry before nightfall.

Contact your local unit office of the Virginia Cooperative Extension Service for an update on blue mold control measures.

Blue Mold Reporting and Advisory Service for Virginia: A system for tracking the presence and progress of blue mold in Virginia and the United States will be continued for 1988. The reporting system involves tobacco producers, extension agents, and the blue mold coordinator for Virginia. Virginia tobacco producers should scout plant beds and fields for presence of blue mold and report suspected blue mold to the local unit office of the Virginia Cooperative Extension Service. Tobacco producers will be kept informed of the presence of blue mold in Virginia and the chance of correct environmental conditions for blue mold infection.

Black Shank and Granville Wilt: Recording disease levels at the end of each season allows growers to evaluate the cost-effectiveness of their disease control program. To determine the approximate disease level for black shank and/or Granville wilt, count the number of plants with each disease and the total number of plants in every 10th row. Calculate the percentage of diseased plants by dividing the number of diseased plants by the total number of plants.

<u>Severity Level</u>	<u>Black Shank or Granville Wilt</u>
Low	Less than 1%
Moderate	1-5%
High	More than 5%

Disease levels should be recorded each year for each field. Varieties with moderate to high resistance should perform acceptably in fields with no observable black shank or Granville Wilt injury in recent years. No chemical treatment should be needed. The following control options can also be used as a guide for reducing losses to black shank and Granville wilt:

<u>Severity Level</u>	<u>Control Option*</u>
Low	2-year rotation and highly resistant
Moderate	2- to 3-year rotation, a highly resistant variety and a recommended soil chemical
High	3- to 4-year rotation, highly resistant variety and a recommended soil chemical

*Continuous culture (tobacco following tobacco) is not recommended. However, if tobacco following tobacco cannot be avoided, use only varieties with high disease resistance and a recommended soil chemical. In this situation, disease losses may occur regardless of control procedures.

Nematodes: Root knot, lesion, and tobacco cyst nematodes are major pests of flue-cured and dark-fired tobacco. Although nematodes rarely cause losses in burley and sun-cured tobacco, the possibility of nematode problems should not be ignored. Since plant symptoms caused by nematode injury are often confused with other problems, nematodes may go undetected for years. Nematode control depends upon a positive identification of the nematode species, because the specific pesticides, rotation crops, and varieties vary among the different types of nematodes that damage tobacco.

Nematode identification: A Nematode Assay Clinic at Virginia Tech provides two types of nematode assay: the Diagnostic Nematode Assay and the Predictive Nematode Assay. The Diagnostic Nematode Assay is conducted to determine if plant parasitic nematodes are the cause of stunted or unthrifty plants. However, nematodes may be only one of many factors which must be considered in the diagnostic procedure. A sample of plant roots should always accompany soil samples submitted for the diagnostic nematode assay. When possible, whole plants should also be submitted. When nematodes are found to be the cause of problems on tobacco, it is usually impractical to initiate control measures until the year following the diagnosis. The Predictive Nematode Assay focuses on sampling for nematodes in the fall to identify fields with damaging nematode populations so that control measures can be initiated before or at the time of planting. Any soil samples which are submitted for this type of assay should be obtained by a systematic sampling procedure. A separate soil sample must be taken for each field. Soil should be collected by removing an equal amount of soil from at least 25 places throughout the entire field. Predictive nematode assay samples must be received by VPI by November 30 for results to be available by planting. Assay results indicate the presence or absence of economically significant nematode populations. If damaging nematodes are not found, the producer can choose not to use a nematicide. In addition, the type and number of nematodes will influence the choice of nematicide if one is needed. Savings from the use of this assay range from \$50 to \$1000/A depending on the nematicide problem. Contact your local Cooperative Extension Service Office for information on methods of collecting samples and interpreting assay results.

Root Knot and Lesion Nematodes: The following practices are recommended for control of root knot and lesion nematodes in Virginia tobacco fields:

1. Use nematode free transplants from fumigated plant beds.
2. Rotate tobacco at two-to-four year intervals with non-susceptible crops such as a small grain, fescue, sudangrass. Avoid preceding tobacco with soybeans other crops susceptible to the same nematodes as tobacco.
3. Plant root knot resistant varieties.
4. A nematicide rated '3' or above can be used when nematode assay results show less than 200 root knot nematodes or 100 lesion nematodes per 500 cm³ of soil. Nematicides rated '4' or above should be used for higher populations.
5. Practice early stalk and root destruction
6. Predictive nematode assay.

Root Knot Level

Slight to low (0 to 200 larvae)
Moderate to high (more than 200 larvae)

Control Option*

Nematicide or resistant variety + nematicide
Nematicide and resistant variety

*Rotation is recommended when nematodes are present. Use 2- to 4-year rotation for moderate to high levels. Continuous culture of tobacco is not recommended. Use resistant varieties combined with chemical control if continuous culture cannot be avoided.

Tobacco cyst nematode (TCN) (*Globodera solanacearum*) - This destructive nematode is widespread on a large number of tobacco farms in Amelia, Brunswick, Dinwiddie, Lunenburg and Nottoway Counties. In addition, this nematode has been found on 1 or 2 farms in Chesterfield, Greensville, Mecklenburg and Prince Edward Counties. All tobacco producers in the TCN-infested counties should take a predictive nematode sample each year to monitor the presence of TCN. Yield losses are particularly high when tobacco follows tobacco and a nematicide with a performance rating of 3 or below (for root knot nematode control) has been used. Remember, the use of any nematicide for TCN control does not guarantee against yield losses.

The following measures should be taken to prevent the introduction of TCN into a field.

1. Do not obtain transplants from farms with a cyst nematode infestation.
2. Do not obtain transplant water or irrigation water from ponds or streams which receive drainage water from infested fields.
3. Do not use equipment which has been previously used on infested land until it has been thoroughly cleaned. This also applies to equipment of custom applicators of fertilizers, herbicides and pesticides.

Fields already infested with the cyst nematode should be managed as follows:

1. Rotate tobacco with corn, sorghum, small grains or fescue.
2. Use a nematicide with a rating of 4 or above (1988 Production Guide).
3. Practice early stalk and root destruction.
4. Take soil samples for the predictive nematode assay.
5. Remember, if tobacco is grown every year on infested soil, there is no guarantee that either fumigant or nonfumigant nematicides will prevent losses from the tobacco cyst nematode.

Black Root Rot - This disease is common in burley in Southwest Virginia and the western and northern part of the flue-cured, dark-fired, and sun-cured area. Stunted plants with black and reduced root systems are symptomatic of black root rot. Plants may recover as soil temperatures increase. Control practices include: 1) planting resistant varieties; 2) keeping soil pH at 5.6 (no lower than 5, no higher than 6); 3) using a 2- to 4-year rotation with small grains or corn. (Do not precede tobacco with red clover, soybeans or other legumes since the same pathogen infects these crops); 4) using a multipurpose fumigant; 5) avoiding early planting; and 6) improving drainage.

Tobacco mosaic virus (TMV) - TMV particles exist in the sap of infected plants. Anything that moves sap or "juice" from diseased to healthy plants will also move the virus. TMV can spread from manufactured tobacco products, old tobacco sheets, undecayed tobacco roots and stalks left in the soil from previous crops, and from weed hosts such as horse-nettle and ground cherry. Washing hands regularly with phosphate detergent during transplanting, or spraying plants with milk, can help reduce TMV incidence early in the season. Roguing infected plants before layby will reduce spread of the virus within a field. TMV cannot be eliminated without faithful use of crop rotation and early root and stalk destruction. Most burley varieties (except TN86) are TMV-resistant. Flue-cured tobacco varieties 'NC 567' and 'Coker 176' are also TMV-resistant, as is the dark-fired tobacco variety 'Va 312.' TMV-resistant varieties should be planted in flue-cured tobacco fields with a history of 30 to 50% of the plants being infected by TMV by the topping stage.

Other viruses - **Tobacco etch virus (TEV)**, **Tobacco vein mottling virus (TVMV)**, **Cucumber mosaic virus (CMV)**, **Peanut stunt virus (PSV)**, **Potato virus Y (PVY)**, **Tobacco ringspot virus (TRSV)** - TVMV and TEV are the most common viruses found in burley tobacco. TVMV and TEV frequently occur together and are often referred to as a virus complex. Other less common viruses found in the burley virus complex are TRSV, CMV and PSV. Excluding TRSV, all of these viruses are transmitted by several aphid species when they feed on infected weeds and then move into tobacco. Overwintering hosts of these viruses include horsenettle, ground cherry, curly dock (for TVMV), and clovers for CMV and PSV. Symptoms of virus infections vary greatly depending on the virus involved, time of infection and variety. Virus infected plants may show mosaic, vein clearing, stunt, chlorosis, vein banding, etch, and death of veins. The earlier the plants become infected the more severe the stunting, chlorosis and necrosis. Yield reductions may exceed 50% if sensitive varieties are infected early. There are no known methods to prevent infection, nor are chemicals available to cure a virus-infected plant. The following practices, however, may reduce the severity of losses caused by aphid-borne viruses: 1) use tolerant varieties (Burley tobacco variety 'TN 86' is very tolerant of TVMV and TEV); 2) reduce overwintering hosts; 3) reduce aphid transmission; and 4) timely planting.

The previously mentioned viruses can occur on all types of tobacco in Virginia. However, their importance on flue-cured, dark-fired and sun-cured is minor. PVY (vein banding) can occur on flue-cured tobacco and cause serious losses. TRSV is usually of minor importance but may occur on all types of tobacco grown in Virginia.

Fusarium Wilt - This disease is rarely a problem and most varieties carry some resistance. When a high infestation level is present, use a multipurpose fumigant and a 2-year rotation. Do not rotate with sweet potato.

Verticillium Wilt - Rarely a problem and some resistant varieties are available. When a high infestation level is present, use a multipurpose fumigant and a 2-year rotation.

Application Methods

The performance and safety of a chemical is dependent on following the proper application methods. Proper application procedures will avoid crop injury and poor disease control.

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

Foliar Spray (FS) - Apply with either a hand sprayer or boom sprayer equipped with either a disc-core type of cone nozzle (D3-45, etc.) or hollow cone nozzle (TX12, etc.). Apply fungicide at 50 psi in 20 to 50 gallons of water per acre. Increase the amount of water as the plants increase in size. Cover both top and bottom of leaves. The use of drop nozzles in field tobacco increases plant coverage. **Plant Bed** - Begin application when plants are about the size of a dime. Application

must be made before infection occurs. Repeat twice weekly or more often if sprays are washed off with rain or irrigation. Continue treatment until transplanting is complete. Field - Make applications when disease is predicted or threatens and repeat at 7-day intervals or 3- to 4-day intervals during weather conditions ideal for disease development. Repeat application after a rain.

Foliar Spray - Bluestone-Lime mixture (Bordeaux mixture) (FS-B) - To prepare Bluestone-Lime mixture (Bordeaux mixture) follow these directions exactly: 1) Fill a clean 50 gallon barrel 3/4 full of water strained through a cloth. 2) In one container thoroughly mix 4 pounds of fresh commercial hydrated lime in 4 gallons of clean water. 3) In another container dissolve 3 pounds of powdered bluestone in about 4 gallons of water. 4) Pour the lime paste into the barrel of water and stir vigorously. While stirring, add the bluestone solution slowly. 5) Add water to make 50 gallons. Use 1 quart of solution per sq yd of plant bed. First application should be made when plants are about the size of a quarter and again 10 days later. Apply without removing the tobacco bed cover. Use an ordinary sprinkling can or a power sprayer. Stir each time the sprinkling can is filled, or stir constantly when using a power sprayer. Apply the Bluestone-Lime mixture so as to cover the entire plant bed as well as the plowed area on each side and on the ends for a distance of 2 to 3 feet beyond the bed. This material is caustic and may damage sprayer, so clean thoroughly immediately after use.

Fumigation-Field Procedures - The tobacco producer should choose the correct fumigant and dose rate to control the diseases and/or nematodes present in each field. Refer to accompanying tables for information on correct dosage rates for each disease and/or nematode. Use higher rates for heavier soils or higher disease infestations. Soil should be in good seed bed condition, free of clods and undecomposed plant material and with soil moisture at about 1/2 of field capacity when fumigants are applied. If undecomposed plant material is present, plow down and allow to decompose before applying fumigant. Soil temperature should be 50^o to 80^o F at the depth of injection. Fumigants can be applied by the following procedure: 1) Row treatment - inject the fumigant 6 to 8 inches deep with one chisel-type applicator in center of the row. In the same operation as fumigant application, seal the soil by bedding the fumigated row area with enough soil to bring the soil surface 14 to 16 inches above the point of infection. 2) Broadcast treatment - Space chisels 8 inches apart and inject fumigant 10 to 12 inches below the soil surface. Immediately seal in the fumigant with a roller, drag or similar equipment.

After fumigation, leave soil undisturbed for an 'exposure period' of 7 to 14 days. Cold, wet soil retards diffusion of fumigants and requires a longer exposure period. Soil should be aerated at the end of the exposure period. Planting is generally considered safe when a residual odor of the fumigant is no longer detectable in the soil root zone. This condition is usually reached approximately 3 weeks after fumigation. The following procedures can be used to hasten aeration, especially if rains or cold temperatures occur during the exposure period: 1) Row - Use a chisel in the bed without turning the soil. 2) Broadcast - Plow or deep cultivate to the depth of the treatment zone. Caution: In both types of treatment avoid contamination of treated soil with untreated soil. Do not rehill row if there is a danger of contamination with untreated soil. Use only transplants known to be disease free. Do not use tools, equipment and/or residues that are infected with soil-borne diseases. Remember, plant injury will occur if fumigant is still present in the soil at transplanting.

Precautionary and Restriction Statements: 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.

Plant Bed Diseases

Disease	Chemical	Product	Rate/100 sq yds	Remarks	
Nematodes, insects, weeds, (see remarks)	methyl bromide (98%) + chloropicrin (2%)	Brom-O-Gas etc.	9.0 lbs OR 18.0 lbs	Fall fumigation is preferred. Prepare seedbed as you would for seeding. You must use an air-tight cover. Treat at soil temperature above 55° F. Expose soil to chemical for at least 24 hours and then aerate 24 to 48 hours before seeding. The hot-gas method will permit shorter exposure time. METHYL BROMIDE IS EXTREMELY POISONOUS. Use high rate (18.0 lb) for fungal diseases; Damping off - (Pythium, Rhizoctonia, Fusarium), black shank and tobacco cyst nematode. Read precautionary statements.	
	Nematodes, insects, weeds, damping-off, black shank	methyl bromide (66%) + chloropicrin (33%)	Terro-gas 67 etc.	7.23 lbs	Same as for previous remarks. Use higher rates for high pest infestations. Read precautionary statements.
		metham (32%) (SMDC)	Vapam	1.5 gals	Fall fumigation is preferred. Prepare seedbed as you would for seeding. Apply to freshly prepared moist soil when temperature is above 55° F. Tarp Method: inject chemical to a depth of 5 inches or spray or drench at rate of 1.5 gal in 40.0 gal of water per 100 sq yds. Apply uniformly over the entire area. Cover area immediately with plastic no less than 1 day, but no more than 2 days. After removing plastic—cultivate soil lightly and wait 7 to 14 days prior to planting in treated area. Read precautionary statements.
	methyl isothiocyanate (MIT) (80%)	Vorex	1.0 gal	Fall fumigation is preferred. Inject to a depth of 5 inches and cover with plastic immediately. Treatment should be at least 4 weeks before seeding. Remove cover at least one week prior to seeding and work soil lightly. Aerate by cultivating and delay planting 7 days for each 23 pounds of active ingredient used per acre. Read precautionary statements.	
Damping-off (Pythium spp.)	metalaxyl	Ridomil 2E	0.66 oz or 4 tsp (1.0 qt/A)	Apply broadcast just before or at time of seeding in 2 gals of water. Rake or irrigate plant bed with 1/2 inch of water to incorporate chemical.	

Foliar Plant Bed Diseases

Chemical	Material	Product/A	Rate		Application Methods ¹	Disease ²		
			Product/100 Sq/Yds	Gals/100 Sq Yds		AN	BM	ALS or WF
Systemic Fungicide								
metalaxyl	Ridomil 2E	1.0 qt	4 tsps (2/3 oz)	2	preplant	--	X	--
metalaxyl + a protectant fungicide	Ridomil 2E + a protectant fungicide	1.0 pt + see below	2 tsps (1/3 oz)	2 to 5	FS-delay	-- or X	X	-- or X
Protectant Fungicides and/or Bactericides³								
ferbam	Carbamate	2.0-3.0 lbs	4 tbsps	2 to 5	FS	--	X	--
Lime + copper sulfate	Bluestone-Lime (Bordeaux mixture)	4.0 lbs + 3.0 lbs	--	--	FS-B	--	--	X
mancozeb	Dithane M-45, Manzate 200 (etc.)	1.5-2.0 lbs	2-3 tsps	2 to 5	FS	X	X	--
maneb	Dithane M-22, Manzate (etc.)	1.5-2.0 lbs	2-3 tsps	2 to 5	FFS	X	X	--
maneb + zinc	Dithane M-22, Special Maneb, Special, Manzate D, etc.	1.5-2.0 lbs	2-3 tsps	2 to 5	FFS	X	X	--
metiram	Polyram 80WP	2.0-2.5 lbs	2-3 tbsps	2 to 5	FS	X	X	--
streptomycin sulfate	Agri-mycin 17 Agri-strep, etc.	0.25-0.50 lb (100-200 ppm)	2-4 tsps	2 to 5	FS	--	--	X
zineb	Dithane Z-78, Zineb 75WP, etc.	2.0-3.0 lbs	4 tbsps	2 to 5	FS	--	X	--

¹FS - Foliar spray - refer to previous section on application methods; **Preplant** - Apply broadcast just before or at time of seeding to soil surface. Incorporate by irrigation or raking; **FS-delay** - Apply Ridomil 2E as a foliar spray to plant beds treated preplant with Ridomil 2E when plants remain in beds beyond normal transplanting periods or 70 days after seeding. Apply protectant fungicide at 7 day intervals. **FS-B** - refer to previous section on application methods.

²AN = Anthracnose; BM = Blue Mold; ALS = Angular Leaf Spot; WF = Wildfire.

³**Warning** - Protective fungicides may not control disease when applied after infection or symptom expression.

Plant Bed Diseases

Disease	Chemical & Formulations Active Ingredient	Rate	Remarks
Tobacco mosaic virus (TMV)	Milk (whole or skim)	5.0 gals/ 100 sq yds of bed	Spray plants in plant bed from 1 to 24 hours before pulling. See discussion on control of TMV. Should be combined with washing hands with phosphate detergent.
	Milk (dry skim)	5.0 lbs in 5.0 gals water/100 sq yds	
	Phosphate detergent	1/4 cup/gal of water	Wash hands every 15 minutes during pulling and transplanting operations. Should be combined with spraying plants with milk.

Field Diseases

Disease	Material Rate/A	Method of Application	Remarks
Black shank (<i>Phytophthora parasitica</i> var. <i>nicotianae</i>)	Ridomil 2E; 2.0-4.0 qts (flue-cured) 4.0-6.0 qts (burley and other types)	Apply broadcast and incorporate in the top 2-4 inches of soil.	Use the low rate of Ridomil in fields with expected levels of black shank (less than 6%) Use the high rate of Ridomil when the expected level of black shank is high (greater than 6%). Ridomil should always be used in conjunction with crop rotation and resistant varieties. Failure to control nematodes in fields treated with Ridomil may result in poor control of black shank. Control in burley tobacco is increased when used in combination with resistance, except for L8 type resistance in presence of race 1. Ridomil use may not be necessary when a resistant variety is planted in a long-term rotation (5 yrs or more). Tobacco, corn, or root crops may be planted the year following Ridomil treatment. Small grain cover crops may be planted in the fall following treatment, provided they are plowed down and not used for food or feed. Other crops may be planted 18 months following application. Consult label for chemicals compatible with Ridomil and approved rotation crops.
	Ridomil 2E; 1.0 qt	Apply as a broadcast or band soil application just before the last cultivation.	Use with a preplant application of Ridomil for prolonged control of black shank in field planted tobacco Preplant rates may be reduced if used with layby application. Consult with Extension Agent. Do not make this lay-by application if more than 2 qts per acre of Ridomil 2E was used before transplanting.
	Telone C-17; 8.5-10.5 gals	Inject 8 inch deep with one shank in center of row when soil temperatures are above 50 F	Use of a soil chemical is only necessary for moderate to high disease pressure (more than 5% of stand killed in previous crops). Use higher rates for heavier soils or higher pest infestations. Refer to previous comments on black shank control and fumigation practices. Fumigants should always be used in conjunction with lost resistance and crop rotation. See Bull. 393 "Crop Rotation for Flue-cured Tobacco."
	Vorlex; 5.0 gals	Wait 2-3 weeks after fumigation before planting. Rates based on 42 inch rows.	
	Chlor-O-Pic; 3.0 gals		
	Vorlex 201 5-8 gals		

Field Diseases (cont'd)

Disease	Material Rate/A	Method of Application	Remarks
Blue mold (<u>Peronospora tabacina</u>)	Ridomil 2E; 1.0-2.0 qts	Apply broadcast and incorporate in top 2-4 inches of soil.	<u>Flue-Cured, dark-fired, and sun-cured</u> - Apply 1 qt for early season control. <u>Burley</u> - Apply 2 qts per acre. <u>Note:</u> Do not use Ridomil in transplant water or in foliar application on field-grown tobacco. These application methods are less effective, increase chance of resistant strains and may cause plant injury. Tobacco, corn, or root crops may be planted the year following treatment. Small grain cover crops may be planted during the fall following treatment provided they are plowed down and not used for food or feed. Consult label for restrictions on rotational crops and chemicals compatible with Ridomil.
	Ridomil 2E, 1.0 qt	Apply as a broadcast soil application just before lay-by cultivation.	Use with a preplant application of Ridomil for prolonged control of blue mold in field planted tobacco. Do not make this lay-by application if more than 2 qts per acre of Ridomil 2E were use before transplanting. See previous remarks on Ridomil.
	Carbamate (Ferbam); 2.0-3.0 lbs	Foliar Spray: Apply at 50 psi in 20 to 50 gals of water.	Make field applications when disease is predicted or threatens and repeat at 7-day intervals. During active blue mold weather, spray at 3- to 4- day intervals. Repeat application immediately after a rain. Discontinue spray application when disease is no longer a threat. <u>Warning:</u> The preventive fungicides may fail to control blue mold if applied after infection and symptom formation.
	Dithane M-45; Manzate 200; Mancozeb (mancozeb); 1.5-2.0 lbs	The amount of chemical and water depends on size of plant. Use higher rates for mature plants. Cover both top and bottom of leaves. Drop nozzles increase plant coverage.	
Dithane M-22 Special; Manzate D; Maneb special (maneb plus zinc); 1.5-2.0 lbs			
	Zineb 75; Dithane Z-78 (Zineb); 3.0 lbs.		
Granville Wilt (<u>Pseudomonas solanacearum</u>)	Telone C17; 10.5 gals	Same as for Black shank.	Refer to remarks under Black shank. Use higher rates for high infestation levels.
	Vorlex 201; 5-8 gals		
	Chlor-O-Pic; 3.0 gals		
Black Root Rot (<u>Thielaviopsis basicola</u>)	Telone C17; 10.5 gals	Same as for Black shank.	Keep soil pH at 5.6 or between 5 and 6. Use a 2- to 4-year rotation with small grains or corn. Do not rotate with red clover, soybeans or other legumes since the same pathogen that attacks tobacco infects these crops. Multipurpose chemicals applied before transplanting may aid in the reduction of symptoms caused by black root rot. Use higher rates for high infestation levels.
	Vorlex; 5 gals		
	Vorlex 201; 5-8 gals		
	Chlor-O-Pic; 3.0 gals		
Fusarium Wilt (<u>Fusarium oxysporum</u> f. sp. <u>nicotianae</u>)	Vorlex; 5.0 gals	Same as for Black shank.	Most varieties carry some resistance. In severe cases use a multipurpose chemical, and a 2-year rotation. Do not rotate with sweet potatoes since the same fungus attacks both crops.
	galsVorlex 201; 5-8 gals		
	Chlor-O-Pic; 3.0 gals		
Verticillium Wilt (<u>Verticillium albo-atrum</u>)	Vorlex; 5.0 gals	Same as for Black shank.	Rarely a problem. Some resistant varieties are available. Use multipurpose chemicals in severe areas.

Nematodes

Material	Rate/A1	Application Method2	Nematodes3		Remarks
			Root Knot and Others	Tobacco4 Cyst	
Fumigants					
DD or Vidden D	10.0 gals		F-Row	5 C	---
Telone II	6.0 gals		F-Row	5 C	---
Telone C17	10.5 gals		F-Row	5 C	---
Vorlex	5.0 gals		F-Row	5 C	---
Granular or Liquid Non-Fumigants⁵					
Dasanit-Di-Syston 4-2SC	1.5 gals		PPI	2 R	---
Furadan 4F	1.5 gals		PPI	3.0 R	---
Furadan 15G	40.0 lbs		PPI	3.0 R	---
Lorsban 4E	1.25 gals		PPI	3.5 R	---
Mocap EC6	1.3 gals		PPI	3.5 R	---
Mocap 10G	80.0 lbs		PPI	3.5 R	---
Mocap Plus EC 2+4	2.0 gals		PPI	3.5 R	---
Mocap Plus 10-5G	80.0 lbs		PPI	3.5 R	---
Nemacur 3	2.0 gals		PPI	4.5 C	5.0 C
Nemacur-Dasanit 2-4SC	1.0 gals		PPI	4.0 R	---
Nemacur-Dasanit 2-4SC	1.5 gals		PPI	4.5 C	4.5 C
Nemacur 3 + Lorsban 4E	1.0 gals + 0.5 gals		PPI	4.0 R	---
Nemacur 3 + Furadan 4F	1.3 gals + 1.0 gal		PPI	4.0 R	4.5 C
Temik 15G	20.0 lbs		PPI or B-Row	3.5-4.0 R	4.5 C(6)
Vydate L	1.0 pt		TPW	2.0 R	---
Vydate L	1.0-3.0 gals		PPI	3.0 R	---

Mocap - No waiting period is required but at least a 5-day waiting period enhances wireworm control. Use higher rate for more severe nematode problems.

Furadan - Labeled for flue-cured

only. Excessive rates will injure transplants. Measure accurately - over applications may cause stunting of tobacco. A 5-day waiting period enhances wireworm control.

Nemacur-Dasanit - Use higher rate in fields severely infested with nematodes or with a history of severe nematode problems, use higher

Temik - Flue-cured only. Do not apply more than one week before transplanting to obtain optimum control.

Vydate - Measure accurately to avoid injury to tobacco. Use higher rates for fields severely infested with nematodes or with a history of severe nematode problems. Caution: Injury may result from transplant water treatment.

¹Use higher rates for heavy soil types and/or high nematode infestations.

²PPI - Preplant incorporated. F-Row - Inject 8 inches deep in row with single shank - 21 days waiting period before planting. F-Broadcast - Inject 8 inches deep with chisels set 8 inches apart - 21 day waiting period before planting. TWP - Transplant water, use a minimum of 200 gals of water per acre. B-Row - Apply granules with a 10- or 12-inch bander, incorporate into or cover with soil to a depth of 2 to 6 inches when forming beds.

³Control rating - 1 to 5 where 1 is poor and 5 is excellent; R - chemical should be used in a 2- to 4-year crop rotation and only on low to moderate levels of nematodes; C - if rotation is not possible, chemical should be used in continuous cropping of tobacco and when high levels of nematodes are present; (---) - no control or not labeled for disease.

⁴Tobacco cyst (TCN) - *Globodera solanacearum*.

⁵Wait 5 days after application before transplanting except for transplant water treatments and Temik.

⁶Consult with Extension Agent for performance of Temik 15G on TCN.

No Chemical Available for the Following Diseases

Disease	Comments
Brown Spot (<u>Alternaria alternata</u>)	Can be severe on mature tobacco. In addition, this disease can be serious during periods of high humidity. To help reduce losses, use a tolerant variety. Avoid practices that would leave mature leaves in the field or delay the maturity of the tobacco. Sucker control with MH-30 reduces the incidence of brown spot. Early harvest is recommended.
Damping-off (<u>Rhizoctonia</u> spp., <u>Fusarium</u> spp., etc)	Since these diseases can first occur in the plant bed, proper control measures in the plant bed are essential. Choose disease-free transplants. Cool, wet weather following transplanting favors field infection. Do not replant in same spot as dead plant. Refer to plant bed control practices for damping-off caused by <u>Pythium</u> spp. and fumigant rates.
Frenching (nonpathogenic causal agent)	This disorder has been associated with toxins produced by a nonpathogenic bacterium (<u>Bacillus cereus</u>) 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 soil drainage and fertilization can be beneficial. Do not plant in alkaline soils and avoid heavy application of lime.
Frog eye (<u>Cercospora nicotianae</u>)	Avoid over-fertilization with nitrogen. Use a 2-year rotation and be sure to plow-under refuse early. The green spot stage can be avoided by starting the curing process at 38 °C (100 °F) with 100% relative humidity.
Sore Shin (<u>Rhizoctonia solani</u>)	This disease often occurs first in the plant bed, so disinfection of the bed is important. Choose disease-free transplants. There are no field control and no resistant varieties available. Use fumigants in plant beds at correct rates for fungi.
Southern Stem and Root Rot (<u>Scierotium rolfsii</u>)	This disease often occurs first in the plant bed, so disinfection of the bed is important. Choose disease-free transplants. There is no field control and no resistant varieties available.
Virus (mosaic, vein-banding, etc.)	Once a plant is infected, it remains infected for life. See special not on viruses.
Weather Fleck (ozone)	This disorder appears as small brown to tan leaf spots in the spots in the plant bed and field. The major cause of this problem is ozone from car, industrial and natural sources. Hot humid days followed by heavy rains increases severity of the problem. Burley and flue-cured tobacco are more susceptible than dark-fired and sun-cured varieties. Certain varieties within tobacco types are less susceptible than others. Refer to variety information.
Wildfire and Angular Leaf Spot (<u>Pseudomonas tabaci</u> and <u>Pseudomonas agulata</u> , respectively)	Resistant varieties and early harvesting are necessary to prevent losses. Rotation is recommended. Bluestone-Lime or streptomycin sulfate is used in the plant bed to obtain bacteria-free transplants. In addition, streptomycin sulfate can be used in the field.

Disease Reactions of Varieties of Flue-Cured Tobacco

Variety	Rootknot ¹	Black shank	Granville wilt	Fusarium wilt	Brown spot	TMV
Clemson PD4	S ²	M	L	-	--	S
Coker 48	S	H	H	H	MT	S
Coker 176	R	M	H	-	--	R
Coker 187-Hicks	S	H	M	M	SE	S
Coker 206	S	H	H	-	--	S
Coker 319	S	L	L	L	SE	S
Coker 347	R	M	H	H	MT	S
Coker 411	S	H	L	S	SE	S
K 326	R	M	M	-	--	S
K 394	S	H	M	-	--	S
K-399	R	H	H	-	--	-
McNair 373	R	M	H	L	--	S
McNair 944	S	H	L	S	SE	S
NC 13	S	M	L	L	SE	S
NC 79	R	M	L	M	MT	S
NC 82	S	H	H	M	T	S
NC 88	R	M	M	H	T	S
NC 89	R	M	L	L	T	S
NC 98	R	M	M	M	MT	S
NC 628	R	M	M	M	T	R
NC 2326	S	M	S	L	MT	S
SC 72	R	M	H	H	SE	R
Speight G-28	R	H	H	H	T	S
Speight G-52	S	H	M	S	MT	S
Speight G-58	R	M	H	L	MT	S
Speight G-70	R	H	M	L	MT	S
Speight G-140	S	H	M	L	SE	S
VA 115	S	M	L	S	MT	S
VA 182	S	H	M	-	-	S

¹The varieties listed above have been tested against the southern root-knot nematode which is the most common nematode in Virginia.

²S = Susceptible; L = Low Resistance; M = Moderate Resistance; H = High Resistance; T = Tolerant; R = Resistance; MT = Moderately Tolerant; and SE = Sensitive.

Disease Reactions of Varieties of Burley Tobacco

Variety	BS ¹	BRR	TMV ²	WF	FW
Ky10	S	M	H	S	M
Ky14	S	H	H	H	H
Ky15	S	H	H	H	M
Ky17	M	H	H	H	M
Va 509	M	L	S	H	L
Va 528	M	M	-	H	-
B21	S	L	H	H	S
B21 x Ky10	S	L	H	H	L
B21 x Ky14	S	H	H	H	M
Ky14 x L8	2	H	H	H	M
Ky10 x L8	2	M	H	H	M

¹BS = Black shank; BBR = Black root rot; TMV = Tobacco mosaic virus, WF = Wildfire; and FW = Fusarium wilt. Resistance levels: H = High, M = Moderate, L = Low, S = Susceptible, and - = Not determined.

²High resistance to Race 0 (immune) and no resistance to Race 1. Continuous use of L8 resistance may select for Race 1.

Disease Reactions of Varieties of Dark Fired Tobacco

Variety	BS ¹	BRR	TMV	RK
Brown Leaf	S	L	S	S
Daniel Special	S	S	S	S
Hastings	S	S	S	S
Lizard Tail Orinoco	S	S	S	S
Nance	S	S	S	S
Va 309	M	L	S	S
Va 310	M	L	S	S
Va 312	S	H	R	S
Va 331	M	L	S	S
Walker's Broad Leaf	S	L	S	S
MS Va 331 x Va 312	L	M	S	S

¹BS = Black Shank; BRR = Black Root Rot; TMV = Tobacco Mosaic Virus; H = High Resistance; M = Moderate; L = Low; S = Susceptible; R = Resistant.

Weed Control in Tobacco

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Weed control is an important part of producing a quality tobacco crop. The control of weeds in tobacco is accomplished by two or more cultivations or with the combination of herbicides and cultivation. Under normal growing conditions and weed populations, weeds can be controlled by cultivation until the last cultivation. However, wet soils after transplanting often delay cultivation. The use of a last herbicide before planting or at transplanting will control weeds early in the growing season. In addition, weeds are often a problem in the row middles after the last cultivation. Repeated cultivations can remove the herbicide from the row middles and weeds may occur when a herbicide was used preplant or at transplanting. A herbicide can be applied after the last cultivation in the row middles. This treatment prevents build up of weeds in row middles and reduces the obstruction of weeds during harvest.

Soil texture - The proper performance and safety of a herbicide is usually dependent on the soil texture and percent organic matter. The rate of a herbicide will increase from low to high with a change in soil texture from coarse to fine. In addition, the rate of the herbicide increases with an increase in organic matter. In general, use the herbicide rate for soil texture when soils have 1 to 2% matter. When less than 1% organic matter is present, use the low recommended herbicide rate regardless of soil texture. The amount of organic matter can be determined from a soil sample. Contact your local unit office of the Virginia Cooperative Extension Service for information on soil texture and organic matter. The use of the wrong herbicide rate for a soil texture may result in crop injury or poor weed control. The soil textures are listed in the recommendations as follows:

Coarse - Sands; loamy sands; sandy loams

Medium - Sandy clay loams; loams; silt loams; silts

Fine - Clay loam; silty, clay loams; clays

Soil Preparation - Herbicides used in tobacco do not control established weeds but do control weeds during germination. Before application of herbicide, all weed growth and crop stubble must be thoroughly worked into the soil prior to planting. The soil should be moist and loose with all clods broken down.

Application methods - The performance and safety of a herbicide is dependent on following the proper application methods. Proper application procedures will avoid severe crop injury and poor weed control. There is no place for shortcuts in herbicide application and special effort should be made to apply herbicide as stated on the product label.

Spray equipment - For liquid and wettable powder herbicide formulations, use a standard low pressure (25 to 50 psi) boom sprayer. Apply from 20 to 40 gallons of water per acre. Before use, calibrate sprayer to deliver proper spray gallonage and uniform spray pattern. Check sprayer performance frequently during application. Use 50 mesh screens in strainers, nozzles, and suction units. Clean nozzles and screens frequently. To insure uniform application, replace worn out sprayer, boom and nozzle parts. Maintain continuous agitation and do not leave spray mixture in tank overnight. Wind can cause uneven coverage, therefore do not apply in strong wind.

Preplant incorporated (PPI) - Apply herbicides in an even broadcast application before planting by previously mentioned procedures. Avoid spray overlap. Use boom sprayer equipped with fan-type nozzles (8004, etc.), flood jet nozzles (TK4 etc.) or raindrop nozzles. Incorporate herbicide immediately after application (see label) with the following recommended equipment.

1. Disc - (Combination, tandem, double-disc, disk harrow or similar equipment) - Set disc to cut 4 to 6 inches deep and operate in two different directions (directions should be at right angles to each other) at 4 to 6 mph. A disc set to cut 4 to 6 inches will incorporate herbicide in the top 1 to 2 inches of soil.
Precautions - Avoid use of a large field disc. Discs should be set no more than 8 inches apart and be no wider than 24 inches in diameter. A disc operated one time does not provide adequate incorporation and will result in an increase in crop injury and a decrease in weed control. Shallow incorporation with implements set to cut less than 2 inches deep may result in erratic weed control. Use of incorporation equipment and tractor speeds not listed on the label may result in poor or erratic weed control and/or crop injury.
2. P.T.O.-driven equipment (tillers, cultivators, hoes) - Set equipment to cut 3 to 4 inches deep and operate one time at 4 mph. This type of equipment performs best on coarse soil types. P.T.O.-driven equipment should not be operated at a speed greater than 4 mph.
3. Other equipment can be used but proper procedures should be followed. Read labels or manufacturer's directions.

Overtop after transplanting (OT) - Apply herbicide by previously recommended procedures. Use only herbicides labeled for an overtop after transplanting application. The OT application can be applied as a band or broadcast application. Apply to freshly prepared soil 0-7 days after transplanting. When applied more than 2 days after transplanting, tillage is required immediately before or at time of application to destroy germinating weed seeds. In addition, cultivation is needed if irrigation or rain fall occurs before application during the 0-7 day period.

- Band application** - Apply herbicide in a 14 to 24 inch band over the top of transplants during transplanting. Use fan-type even spray nozzles (8004E, etc.) on spray equipment attached to transplanter. Refer to label, product information, and extension agent for information on this type of application. The amount of herbicide required per crop acre is reduced with band application and can be determined by the following formula: $\frac{\text{Lbs of product/acre} = \text{Band width (inches)}/\text{Row spacing (inches)} \times \text{Broadcast rate in lbs/A.}}$
- Broadcast** - Apply herbicide in an even broadcast application with a sprayer equipped with fan-type nozzles (8004, etc.). Use recommended amount of product/acre.

Layby - Apply labeled herbicides as a directed spray to the row middles immediately after the last normal cultivation. The last cultivation should leave the row middles weed-free for application. Application should be made using commercially available drop nozzles equipped with flood jet flat nozzles (TK2, TK4, etc.) or even flat fan nozzle (8004E, etc.) treatment to be made in a 16 to 30 inch band in the row middles. In fields where the spray boom passes over the same row middle twice, use nozzles which apply one-half (1/2) the normal number of gallons per acre to prevent over application. Use the following formula to determine the amount of product to use with band application: $\frac{\text{Product/acre for band treatment} = \text{Band width (inches)}/\text{Row spacing (inches)} \times \text{Broadcast rate of product/A.}}$ One-half inch of water is usually necessary within 7 to 10 days after application for herbicide activation.

Weeds - A herbicide should be selected that will control the weeds in each field. Identify the problem weed before the selection of a herbicide. The majority of the herbicides used in tobacco will control grasses and a limited number of broadleaf weeds. The weeds a herbicide will control are listed on the label. Several of the herbicides will control a few of the problem weeds and are listed as follows:

- Ragweed** - Suppression (60 to 80% control) of ragweed by either Enide 50W, Enide 90W or Devrinol 50W.
- Nutsedge** - Tillam 6E or 10G will control nutsedge but offers only short-term grass control. Grass control can be extended by a combination with one of the other tobacco herbicides or the application of a herbicide at layby.

Other hard to control broadleaf weeds such as morningglory, prickly sida, velvetleaf, cocklebur, horsenettle, etc. need to be controlled by use of the proper herbicides in the rotation crop. Extension agents can provide assistance in determining weeds present in fields and in the selection of herbicides for tobacco and rotational crops.

Relative Effectiveness of Herbicides for Tobacco*

Grasses and Nutsedge

	Barnyardgrass	Crabgrass	Fall Panicum	Foxtails	Goosegrass	Johnsongrass (Seedling)	Nutsedge
Balan	G	E	G	E	E	G	N
Devrinol	GG	EEEE	GG	EEEE	EEEE	PF	NN
Enide	GG	EEEE	GG	EEEE	EEEE	F	NN
Paarlan	GG	EEEE	GG	EEEE	EEEE	G	NN
Prowl	GG	EEEE	GG	EEEE	EEEE	GG	NN
Surflan	GG	EEEE	GG	EEEE	EEEE	GG	NN
Tillam	GG	EEEE	GG	EEEE	GG	GG	GG
Tillam + Devrinol	GG	EEEE	GG	EEEE	GG	GG	GG
Tillam + Paarlan	G	E	G	E	E	G	G

Broadleaf Weeds

	Carpet-weed	Cockle-bur	Jimson-weed	Lambe-quarters	Morning-glory	Pig-weed	Purs-lane	Prickly sida	Rag-weed	Smart-weed
Balan	G	N	N	G	N	G	G	N	N	P
Devrinol	G	N	N	GG	N	GG	GG	N	F	PP
Enide	G	N	N	GG	N	GG	GG	N	F	PP
Paarlan	G	N	N	GG	N	GG	GG	N	N	PP
Prowl	G	N	N	GG	N	GG	GG	N	N	PP
Surflan	G	N	N	GG	N	GG	GG	N	N	PP
Tillam	G	N	N	GG	N	GG	GG	N	N	PP
Tillam + Devrinol	G	N	N	GG	N	GG	GG	N	F	PP
Tillam + Paarlan	G	N	N	G	N	G	G	N	N	P

*E = 90 to 100% control; G = 75 to 90%, F = 50 to 75%, P = 20 to 50%, N = Less than 20%. This table give 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.

Effect of PPI Applications on Early Season Growth of Tobacco - Herbicides applied preplant may cause a temporary delay in plant growth during the first month after transplanting. This reduced plant growth is related to the effect of the herbicide on root development. In addition, the delay in plant growth varies among herbicides and application procedures. The improper application factors which enhance root injury are: 1) Improper herbicide incorporation; 2) wrong herbicide rates for soil texture; 3) poor application techniques and equipment. If all procedures for the preplant application of a herbicide are followed, the delay in plant growth should be minimal. However, the application of a herbicide at transplanting and/or after the last cultivation will eliminate the delay in plant growth caused by PPI treatment of a herbicide.

The delay in plant growth is usually only temporary and under favorable growing conditions, has no effect on midseason plant vigor or yields. However, the delay in plant growth may be increased by unfavorable growing conditions and other causes of delayed plant growth are diseases, insects, poor transplants, fertilizer injury, and many others. The cause of the delay in plant growths should be identified in order to prevent or reduce repeated occurrences of this problem. The local unit office of the Virginia Cooperative Extension Service will aid in the solution of this problem.

Effect of Herbicide on Small Grain Crops - Residues of some of the tobacco herbicides especially Devrinol applied PPI may affect the growth of small grain crops following tobacco as indicated on product labels. If the small grain is grown only as a cover crop, the problem is not considered serious. The potential for carry over can be reduced by: 1) using minimum labeled rates of the chemicals; 2) band applications of labeled products at transplanting and/or at layby; 3) early stalk and root destruction; 4) deep plowing before seeding of small grain.

Plant Beds

Weed Problems	Chemical	Product	Rate/100 sq yds	Remarks
Most annual weeds	methyl bromide (98%) + chloropicrin (2%)	Brom-O-Gas, Dowfume MC2, etc.	9.0 lbs	Fall fumigation preferred. Prepare seedbed as you would for seeding. You must use an airtight cover. Soil temperatures should be above 55° F. Expose soil to chemical for at least 24 hours and then aerate 24 to 48 hours before seeding. The hot-gas method will permit shorter exposure time. METHYL BROMIDE IS EXTREMELY POISONOUS.
	methyl bromide (66%) + chloropicrin (33%)	Dowfume MC-33, Terr-O-Gas, etc.	7.23 lbs	Same as for previous remarks. Read precautionary statements.
	metham (32%) (SMDC)	Vapam	1.5 gals	Fall fumigation is preferred. Prepare seedbed as you would for seeding. Apply to freshly prepared moist soil when temperature is above 55° F. Tarp Method: inject chemical to a depth of 5 inches or spray or drench at rate of 1.5 gal in 40.0 gal of water per 100 sq yds. Apply uniformly over the entire bed. Cover area immediately with plastic no less than 1 day, but no more than 2 days. After removing plastic—cultivate soil lightly and wait 7 to 14 days prior to planting in treated area. Read precautionary statements.
	methyl isothiocyanate (MIT) (80%)	Vorlex	1.0 gal	Fall fumigation is preferred. Inject to a depth of 5 inches and cover with plastic immediately. Treatment should be at least 4 weeks before seeding. Remove cover at least one week prior to seeding and work soil lightly. Aerate by cultivating and delay planting 7 days for each 23 pounds active used per acre. Read precautionary statements.

Plant Beds (continued)

Weed Problems	Chemical	Product	Rate/100 sq yds	Remarks
White clover, most grasses and weeds that escape fumigation	diphenamid	Enide 50W	Coarse 3.0 oz Medium/Fine 4.5 oz	Apply at seeding to control most grasses and weeds that may escape fumigation. Apply in ample water (approximately 3 gal) to spray evenly over bed. If no rainfall occurs within a few days after application of Enide 50W or 90W, irrigate plant bed with no more than 1/2 inch of water. Plants may be 2 to 4 days delayed in reaching transplant size. Read precautionary statements.
		Enide 90W	Coarse 1.7 oz Medium/Fine 2.5 oz	

Field Grown Tobacco

Weed problem	Soil ¹ Texture	Chemical lbs Active Ingredient/A	Product per Acre		Application ² Method	Remarks
Annual bluegrass, barnyardgrass, carpetweed, chickweed, crabgrass, fall panicum, Florida purslane, foxtails, goosegrass, johnsongrass (seedling only), knotweed, lambsquarters, pigweed, purslane, ryegrass, Texas panicum, check label for uncommon weeds	Coarse	benefin	Balan EC	Balan 2.5 G	PPI	Use only on burley or dark tobacco. Apply to clean soil prior to but no earlier than 10 weeks before transplanting and incorporate within 8 hours. Do not shape bed after chemical is applied. Set plants in an upright position so that their roots extend below the layer of chemically treated soil. <u>Some cases of growth retardation and stunting have occurred.</u> Read precautionary statements.
	Medium	1.12	3.0 qts	45.0 lbs		
	Fine	1.12	3.0 qts	45.0 lbs		
Barnyardgrass, carpetweed, crabgrass, fall panicum, Florida pusley, foxtails, goosegrass, johnsongrass from seed, lambsquarters, pigweed, purslane, ryegrass, ragweed (suppression), smartweed, check label for uncommon weeds	Coarse	diphenamid	Enide 50W	Enide 90W	OT, Layby	All tobacco types. Deep cultivation (below 2 inches) may result in poor weed control. Read precautionary statements.
	Medium	4.0	8.0 lbs	4.4 lbs		
	Fine	6.0	12.0 lbs	5.5-6.6 lbs		
		6.0	12.0 lbs	6.6 lbs		

Field Grown Tobacco (continued)

Weed problem	Soil ¹ Texture	Chemical lbs Active Ingredient/A	Product per Acre		Application ² Method	Remarks
Barnyardgrass, carpetweed, crabgrass, fall panicum, Florida pusley, foxtails, goosegrass, johnsongrass from seed, lambsquarters, pigweed, poorjoe, purslane, ryegrass, label for uncommon weeds	Coarse Medium Fine	isopropalin 1.5 1.5 1.5 (2.0 flue-cured)	Paarlan EC 1.0 qt 1.0 qt 1.0 qt (2 2/3 pts flue-cured)		PPI	All tobacco types. Chemical must be incorporated 8 hours after application. Apply no earlier than 5 weeks before transplanting. Read precautionary statements.
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	napropamide 1.0 1.0-1.5 2.0	Devrinol 50W 2.0 2.0-3.0 4.0		PPI, OT, Layby	All tobacco types. For PPI application, incorporate the same day as applied. Small grain injury may occur for PPI application method. Use high rate for burley in southwest Virginia. Read precautionary statements.
Annual bluegrass, barnyardgrass, crabgrass, crowfootgrass, fall panicum, Florida pusley, foxtails, goosegrass, johnsongrass from seed, lambsquarters, pigweed, common purslane, signalgrass, check label for uncommon weeds	Coarse Medium Fine	oryzalin 0.5-0.75 0.75-1.0 1.0	Surflan 4AS 1.0-1.5 pts 1.5-2.0 pts 2.0 pts	Surflan 75W 0.66-1.0 lb 1.0-1.33 lbs 1.33 lbs	Layby	For use on <u>flue-cured tobacco only</u> . A one-half inch rain is needed for activation. Read precautionary statements.
Barnyardgrass, bermudagrass, crabgrass, Florida pusley, foxtails, goosegrass, ground cherry, lambsquarters, henbit, pigweed, purslane, purple nutsedge, yellow nutsedge, check label for uncommon weeds	All types	pebulate 4.0	Tillam 6E 2.6 qts	Tillam 10G 40.0 lbs	PPI	For use on <u>flue-cured or burley tobacco</u> . Incorporate immediately after application. Read precautionary statements.

Field Grown Tobacco (continued)

Weed problem	Soil ¹ Texture	Chemical lbs Active Ingredient/A	Product per Acre	Application ² Method	Remarks
Barnyardgrass, bermudagrass, blackeyed susan, crabgrass, foxtails, Florida pusley, goosegrass, henbit, lambsquarters, millet, common purslane, pigweed, ragweed (suppression), shepherdspurse, signalgrass, purple nutsedge, wild oats, yellow nutsedge, check label for uncommon weeds	All types	pebulate 4.0 + napropamide 1.0	Tillam 6E 2.6 qts + Devrinol 50W 2.0 lbs	PPI	Transplanted tobacco. Incorporate immediately after application. Read precautionary statements.
Barnyardgrass, bermudagrass, carpetweed, crabgrass, fall panicum, Florida pusley, foxtails, goosegrass, ground cherry, johnsongrass from seed, lambsquarters, pigweed, purslane, purple and yellow nutsedge, check label for uncommon weeds.	All types	pebulate 4.0 + isopropalin 1.5	Tillam 6E 2.6 qts + Paarlan EC 1.0 qt	PPI	Transplanted tobacco. Incorporate immediately after application. Read precautionary statements.
Annual spurge, barnyardgrass, carpetweed, crabgrass, crowfootgrass, Florida pusley, foxtails, goosegrass, johnsongrass from seed, lambsquarters, panicums, pigweed, purslane, signalgrass, check label for uncommon weeds	Coarse Medium Fine	pendimethalin 0.75 0.75-1.0 1.0	Prowl 4EC 1.5 pts 1.5-2.0 pts 2.0-2.5 pts (Burley only)	PPI, Layby	Use on transplanted tobacco. Apply chemical up to 60 days prior to transplanting and incorporate into the soil within 7 days after application. Read precautionary statements. May also be applied in a band in row middles at layby. Read label.

¹When the soil type 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; Loams; Silt loams; Silts. Fine - Clay loam; Silty, Clay loams; Clays.

²PPI - Preplant incorporated. Delay in growth may result under adverse weather conditions and/or when poor application practices have been used. OT - Overtop after transplanting as a band or broadcast applications. Layby - Application of herbicide in row middle after last cultivation.

Precautionary and restriction statements - Read all directions, cautions, precautions, and special precautions on each product label.

Balan EC and 2.5G (benefin) - Applied according to directions and under normal growing conditions, Balan will not harm the treated crop. Over application, uneven application, or improper soil incorporation of Balan can result in erratic weed control or soil residue or crop injury. Under stress conditions due to seedling disease, cold weather, deep planting, excessive moisture, etc., delayed crop development or reduced yields may result.

Devrinol 50W (napropramide) - Do not apply more than a total of 4 lbs of Devrinol 50WP per acre in any one season. After harvest or prior to planting succeeding crops, deep moldboard or disk plowing operation must be carried out. Do not seed to alfalfa, small grain, sorghum, or corn 12 months after Devrinol 50 WP application. The injury to rotational crops is lessened when Devrinol 50WP is used after transplanting or layby treatment. When Devrinol 50WP is applied to the soil surface as in after transplanting or layby treatment, rainfall or overhead irrigation following application improves weed control.

Enide 50W and 90W (diphenamid) - Apply this product only as specified on this label. Do not use Enide 50W or 90W in direct combination with fertilizers, insecticides, or fungicides, or with other herbicides except as specifically recommended. Small grain (i.e., wheat, barley, rye, and oats) cover crops may be sown after tobacco harvest provided Enide 50W or 90W was applied as a band treatment reducing the possibility of cover crop injury. Do not use cover crops for food or feed purposes within 6 months after Enide 50W or 90W application. Do not use more than a total of 16.0 lbs of Enide 50W or 8.8 lbs of Enide 90W per acre in both applications.

Methyl bromide (Dowfume MC2, Brom-O-Gas, etc.) - Apply this product only as specified on the label. Methyl bromide is extremely poisonous and all safety precautions must be practiced.

Paarlan 6E (isopropalin) - Applied according to directions and under normal growing conditions, Paarlan will not harm the treated crop. Over application, uneven application, or improper soil incorporation of Paarlan can result in erratic weed control, crop injury, or soil residue. Consult label for directions on tank mixtures with fertilizers, insecticides, fungicides or other herbicides.

Prowl 4EC (pendimethalin) - Applied according to directions and under normal growing conditions, Prowl will not harm transplanted tobacco. Under stress conditions for plant growth such as cold/wet or hot/dry weather, Prowl can produce a temporary retardation of tobacco development. Prowl will aid in the control of and reduce competition from velvetleaf and smartweed. Do not apply Prowl as a post-transplant spray. Winter wheat and winter barley may be planted in the fall after a Prowl spring application in transplanted tobacco. Do not plant winter wheat or winter barley as fallow crops in Prowl-treated land if the fallow crop is planted using no tillage procedures as crop injury may result. Do not feed forage or graze livestock for 75 days after planting wheat or barley in Prowl-treated land.

Surflan 75W and 4AS (oryzalin) - Applied according to directions and under normal growing conditions, Surflan will not harm the treated crop. Do not spray Surflan in the bud of the tobacco plant as crop injury may occur. Over application may result in soil residue and rotational crop injury. A one-half inch rain or irrigation is necessary for activation. Do not plant any root crop for 12 months following application as crop injury may occur.

Tillam 6E and 10G (pebulate) - Applied according to directions and under normal growing conditions, Tillam will not harm the treated crop. Read label directions when Tillam 6E or 10G is used in combination with fertilizers, insecticides, fungicides, or other herbicides.

Vapam (metham) - Apply this product only as specified on the label. Do not get Vapam in your eyes or on your skin, clothing, or shoes. If application requires walking over treated area, wear rubber boots.

Vorlex (MIT) - Apply this product only as specified on the label. Wear protective clothing. However, common protective materials such as rubber gloves and boots may be penetrated by this material. Polyethylene and teflon are the only plastic materials suitable for use with Vorlex. It is advisable to cover shoes and hands with polyethylene. Use goggles when handling this material.

