

7. TOPPING AND SUCKER MANAGEMENT AND USE OF ETHEPHON

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Topping Benefits

Topping tobacco in the button stage (soon after the flower begins to appear) rather than later increases yield and body if suckers are controlled. When tobacco plants are not topped for three weeks after reaching the button stage, yields are reduced by 20 to 25 pounds per acre per day, or about 1 percent per acre per day when normal yields are in the 2,000- to 2,500-pounds-per-acre range. Higher yields reduce per-pound production costs for acreage-related inputs such as chemicals, fertilizers, and some labor expenses. In addition to improved yield and quality, early topping has other advantages:

- It usually allows topping to be completed before harvest begins, helping to spread the workload away from the peak harvest period.
- It reduces the possibility of plants blowing over in a windstorm.
- It stimulates earlier root development, which increases fertilizer efficiency, drought tolerance, and alkaloid production.
- It helps to reduce buildup of certain insects because eggs and larvae are removed with the floral parts.

These significant advantages of early topping far outweigh the disadvantage of earlier sucker growth, which can be controlled with proper use of contact chemicals. Also, sucker growth is often greater as a result of improved varieties and fertility programs, as well as better control of root diseases through the cultural practices of crop rotation, early stalk and root destruction, resistant varieties, and the use of soil-applied pesticides. As a result of these improved practices, plant roots normally have a greater ability to absorb water and nutrients throughout the growing season. The result is a higher yield as well as a greater potential for sucker growth, especially on plants topped in the button stage.

Chemical Sucker Control

Two primary types of chemicals are available for sucker control: (1) contacts (fatty alcohols), which kill small suckers by touching (burning) them; and

(2) systemics, which restrict sucker growth without killing. Contact alcohol chemicals desiccate (burn) tender sucker tissue, while systemic chemicals retard sucker growth by inhibiting cell division. Maleic hydrazide (MH) is the only true systemic because it is absorbed by leaves and translocated through the plant to small sucker buds. Flumetralin (Prime+ and Flupro) is a contact-local systemic because it must touch the suckers to be effective, although it retards sucker growth by inhibiting cell division.

Proper Strength of Contact Fatty Alcohol Sprays

The degree of sucker kill with contact alcohols is directly related to the ratio of chemical to water. Therefore, it is extremely important to mix a specific amount of contact chemical with an exact amount of water. Most other chemicals used to control insects, weeds, and diseases do not share this requirement because growers need add only enough water to uniformly distribute the chemicals.

The suggested ratio for the first application of C₈-C₁₀ contact alcohol products (Off-Shoot T, Fair 85, Kleen-Tac, Sucker Plucker, Royaltac-M, etc.) is 2 gallons in 48 gallons of water; this makes a 4 percent solution. A 5 percent solution is suggested for the second or third application; this is 2.5 gallons in 47.5 gallons of water. The suggested ratio for the C₁₀ products (Antak, Fair-Tac, Royaltac, Ten-Tac) is 1.5 gallons in 48.5 gallons of water; this makes a 3 percent solution. The mixtures should be strong enough to kill both of the tiny suckers in each leaf axil when the solution wets suckers less than 1 inch long. Using more than the suggested amount of water will weaken the mixture, and you will not obtain good control. Using less than the suggested amount of water will strengthen the mixture and may cause leaf burn on tender crops.

Sucker control data (Table 7-1) show the great difference in sucker growth at final harvest when three different concentrations of a contact alcohol solution were applied. Suckers appeared to be under control for several weeks but then grew rapidly as the harvest season progressed, especially where the 2 and 3 percent solutions were applied.

Weak contact solutions, those less than 4 percent for the C₈-C₁₀ products or less than 3 percent for the C₁₀ products, often control only one of the two sucker buds in each leaf axil. Then the suggested rates of the systemic chemicals cannot control sucker growth on vigorously growing tobacco. Therefore, applying weak contact solutions may contribute to the use of excess, late-season applications of MH, which significantly increase MH residues on and in our cured tobacco. A good general rule is to apply a

contact solution that chemically tops 5 to 10 percent of the small, late plants in a field. If no chemical topping occurs during the first application, the solution is too weak to provide maximum sucker control or the application was too late.

Table 7-1. Sucker Growth with Three Different Concentrations of C₈-C₁₀ Contact Alcohol Sprays

Contact + Water (gallons)	Percent Contact	Suckers per Acre	
		(number)	(lb)
1 + 49	2	29,900	6,256
1.5 + 48.5	3	15,600	4,794
2 + 48	4 ^a	7,800	1,950

^a Normal suggested rate of 2 gallons of contact chemical in 48 gallons of water.

Some growers worry about leaf drop with contact alcohol solutions. This is not likely to be a problem unless the crop has been overfertilized with nitrogen and the season is unusually wet for several days after application. Generally, the benefits of increased sucker control from full-strength contact applications far outweigh any negative effects of leaf drop. Using a contact alcohol allows for earlier topping, which increases yields. Its purpose is to provide sucker control between early topping and the time at which the upper leaves are large enough to be sprayed with a systemic chemical without causing distortion.

Another major advantage of contact alcohols, especially where two or three applications are made, is that they shorten the period for the systemic chemical to control suckers after topping. Systemic chemicals containing only MH tend to “give out” six to seven weeks after application. When the harvest season lasts for 10 or more weeks, sucker regrowth often occurs. Flumetralin, another systemic-acting chemical, controls suckers longer than MH does, but its control is further extended when preceded by one or two applications of alcohol contact.

Proper Use of Flumetralin (Prime+ and Flupro)

Flumetralin should be applied like a contact solution but not until the plants are in the elongated-button-to-early-flower stage. This is a few days before MH application is suggested. The objective is to apply flumetralin so that it touches the small suckers like contact solutions do because, unlike MH, flumetralin does not move to sucker buds through the leaves. Flumetralin must first wet the suckers like a fatty alcohol contact before it can stop cell

division like a systemic. Therefore, flumetralin is referred to as a contact-local systemic. It has no true contact activity, and the controlled suckers do not turn brown or black but rather look yellow and deformed for several weeks after treatment.

Because flumetralin needs to run down the stalk and wet the suckers, it should be applied with contact nozzles (TG3-TG5-TG3 per row or equivalents) at a low pump pressure (20 to 25 pounds per square inch [psi]). And because it is not absorbed and moved through the plant, it performs better than MH in dry weather. Applying flumetralin by hand (downstalk application) is likely to wet more suckers than mechanical spraying (overtop), but hand application requires more labor. Like other sucker control chemicals, flumetralin does not completely control suckers longer than 1 inch, so you should remove larger suckers before application. Full-season sucker control can be expected on small suckers wetted by the flumetralin solution, but missed suckers will continue to grow and should be removed by hand. Missed suckers are likely to occur on leaning plants, whether treated with flumetralin or fatty alcohol contacts. Therefore, using MH in a tank mix with flumetralin or within a day or two after flumetralin application will control the missed suckers. This is why the most effective sucker control programs include the use of both MH and flumetralin.

Soil residues of flumetralin applied to tobacco may contribute to stunted early-season growth of later crops, especially small grains and corn but also nonrotated tobacco, particularly if excessive rates are used for sucker control on light, sandy soils. The carryover potential may be greater when a dinitroaniline is used for both weed and sucker control on sandy soils. (See product labels for comments on carryover residues and possible rotation crop injury.) To minimize possible injury to crops planted in the fall or following spring, follow label mixing and rate instructions and do not apply any more spray volume than required to run down to the bottom of the stalks. Rainfall within two hours after application could reduce effectiveness of flumetralin, but reapplication will also increase the potential for soil residue carryover. Therefore, do not reapply if flumetralin washoff occurs. Also, destroy stalks and roots after the last priming and bury them two weeks later with a moldboard plow set at a depth of 5 to 6 inches. Disk once or twice before planting a small grain cover crop.

Growers are advised not to exceed labeled rates of flumetralin whether used alone or in tank mixes with MH. Higher rates will not significantly improve sucker control but may make soil residue levels high enough to stunt crops planted in the fall or spring.

Maximizing Sucker Control and Minimizing Residues with MH

MH has saved many hours of labor since its introduction in the early 1950s. It is widely used for sucker control because it usually is effective, relatively inexpensive, and easy to apply. But high residues can reduce demand by domestic as well as export customers. No suitable alternative to MH has been developed, and sucker control programs without this product have not given consistently good results.

Periodic droughts and the adoption of improved varieties and cultural practices that emphasize yield extend the harvest season and therefore the period needed for good sucker control. Unfortunately, longer harvest seasons, coupled with greater use of mechanical harvesters, have sometimes led to excessive use of MH initially or in additional late-season applications. Consequently, MH residues on and in cured tobacco are often higher than acceptable to buyers.

Several members of the European Community, the major importers of United States leaf tobacco, have adopted an 80-parts-per-million (ppm) MH tolerance on tobacco products. This tolerance may be established by other European countries in the near future. The major competitor for American-style flue-cured tobacco, Brazil, does not use MH and could capture a more significant share of the export market if MH residues do not drop to and remain near the 80-ppm level.

Although an official MH tolerance has not been established in the United States, domestic cigarette manufacturers and all members of the industry are very concerned about poor public perception of any pesticide residues that could reduce tobacco use both here and abroad. Although domestic cigarette consumption is not increasing, the United States is a leading cigarette exporter. Our continued success will depend partially on the domestic manufacturers' ability to provide cigarettes that meet current or potential pesticide tolerances in other countries.

MH is very water-soluble, and residues vary substantially among years and belts. Table 7-2 shows average MH residues by belt since 1990 based on samples collected by the Flue-Cured Stabilization Corporation. Residues are generally lower when both rainfall and yields are relatively high. Also, don't forget that the Farm Services Agency certification you sign annually states that all pesticides you used for flue-cured tobacco production were applied according to label directions. In addition to possible loss of domestic and export markets, continued overuse of MH could result in greater use restrictions.

It is important that the entire tobacco industry, including producers and farm supply dealers, understand the significance of the pesticide residue issue to our industry, particularly to our export market. Also, it would be wise to assume that all pesticides that leave residues on tobacco (not just MHS) will very likely undergo even greater scrutiny and regulation soon.

Table 7-2. Average MH Residues (ppm) by Belt Since 1990

BELT	90-92	93-95	96-98	99-01	02-03	2004
GA-FL	172	129	149	123	170	173
SC Border	180	116	133	83	131	124
NC Border	170	132	141	76	109	117
NC Eastern	147	124	127	102	115	81
NC Middle	112	110	95	70	—	—
NC Old	67	54	45	46	71	37
VA Old	48	41	41	37	32	38
Wt. Average	134	106	113	77	88	90

Below are some suggestions to help lower MH residues without reducing sucker control:

1. Use a reasonable nitrogen rate. Excess nitrogen stimulates sucker growth and delays maturity, which increases the probability of troublesome sucker regrowth in prolonged harvest seasons. A base nitrogen rate of 50 to 80 pounds per acre is suggested, plus adjustment for leaching if needed. The lower portion of the rate range is suggested for finely textured, fertile soils, especially if legume crops were grown in the field the previous year. The higher portion of the rate range is suggested for coarsely textured soils with topsoils deeper than 15 inches to clay. The data in Table 7-3 illustrate the importance of nitrogen rate on sucker control. When the recommended nitrogen rate was exceeded, suckers were more difficult to control. See Chapter 5, “Nutrient Management,” for more information on determining nitrogen rates.

2. Strive for a uniform crop. Good plant uniformity in the field improves the chance for consistently good chemical sucker control. Therefore, it is essential to produce and use healthy, uniform transplants. Also, it is important to maintain soil pH in the range of 5.8 to 6.0, use fertilizer application methods that minimize salts injury, and use only labeled rates and proper incorporation methods for soil-incorporated pesticides, especially herbicides. Always follow label instructions for pesticides or fertilizers added to the

transplant water. These practices reduce early-season root injury and improve crop uniformity, which allows the crop to mature on a normal schedule. This reduces the time that good sucker control is needed, particularly if the nitrogen rate is not excessive.

Table 7-3. Sucker Control with Various Rates of Nitrogen at Kinston and Reidsville, 1993^a

Nitrogen Rate	Sucker Control (%)^a
Recommended - 16 lb/a	87
Recommended	80
Recommended + 16 lb/a	66
Recommended + 54 lb/a	55

^aAverage of two locations. All treatments received two fatty alcohol applications followed by 1.5 gal/a of MH.

3. Maximize early sucker control with fatty alcohol contacts and flumetralin. This is essential if good sucker control is to be maintained with one application of MH at the labeled rate. Because contacts and flumetralin must touch the suckers to be effective, uniform row spacing and proper application speed, boom height, nozzle size and arrangement, and pump pressure are all important for good sucker control. (See product labels for instructions.) For alcohol contacts, mixing concentration is particularly important because the spray must be strong enough to burn out the tender primary and secondary suckers but not strong enough to cause leaf burn. For the C₈-C₁₀ alcohols, a 4 percent spray (2 gallons of product in 48 gallons of water per acre) will usually be sufficient for the first contact application. Most crops can tolerate a 5 percent spray (2.5 gallons of product in 47.5 gallons water) for the second application, unless the crop is unusually tender. A 3 percent concentration (1.5 gallons of product in 48.5 gallons of water) is suggested for both applications of the C₁₀ alcohols. *However, remember that some chemical topping of small plants and slight leaf flecking are good indicators that the contact concentration is strong enough to give good sucker control.*

Timing of chemical application is also important since none of the chemicals, including MH, will adequately control suckers longer than 1 inch. You should make the first contact application as soon as 50 to 60 percent of the plants have a visible button. Contacts usually are more effective if applied three to five days apart when humidity is low and leaf axils are fully exposed—that is, generally between 10 a.m. and 6 p.m. on sunny days, except when the plants are wilted and temperature exceeds 90° F. Also, none of the products

should be applied to plants wet with heavy dew or to those severely drought-stressed.

4. Apply the labeled rate of MH properly. Unlike fatty alcohol contacts and flumetralin, MH is absorbed by leaves and moved within the plant to small sucker buds. Good absorption and systemic movement depend on having good crop growing conditions. Therefore, MH should never be applied on drought-stressed crops or on those wilted by too much rain, high temperatures, or both. It is best to apply MH one to three days after a good rain or irrigation. When irrigation is not available, many growers use flumetralin or one extra contact application to control suckers until enough rain comes for good MH absorption. This should be viewed as “buying time” until rainfall occurs. If soil moisture is adequate but afternoon temperatures will be high enough to cause partial wilting, MH should be applied only during the morning, starting when the leaves are just slightly wet with dew. Afternoon spraying generally is not suggested except on cool, cloudy days when soil moisture is good. It is extremely difficult for growers with large acreages and only one sprayer to take advantage of the best weather conditions for MH application; some should consider buying another sprayer or using larger nozzles to allow faster application.

The labeled rate of MH on flue-cured tobacco is 1 quart per 1,000 plants. Most tobacco in North Carolina is planted at approximately 6,000 plants per acre. *The correct rate for 6,000 plants is 1.5 gallons per acre.* (This rate is suitable for most formulations available in North Carolina, which contain 1.5 pounds of active ingredient per gallon of product; some products contain 2.25 pounds of active ingredient per gallon and should be applied at 1 gallon per acre for 6,000 plants per acre.) *Only one application is permitted unless the first application is washed off by rain.* Even then, research indicates that reapplication of the full MH rate is not needed unless a substantial rain occurs within 4 hours after the first application. Only a half-rate (0.75 gallon of MH per acre) is needed if rain occurs between 4 and 10 hours after the first application. No reapplication is needed if rain occurs more than 10 to 12 hours after the first application. Following these important guidelines will ensure good sucker control with only minimal increases in MH residues.

MH is absorbed more effectively by younger, upper leaves than by older, lower leaves. Therefore, MH should be applied to the upper third of the plant using the three-nozzles-per-row arrangement. Some growers use drop nozzles with high pressure, as they do when spraying for aphids or flea beetles. This will not substantially improve sucker control but will increase MH residues because more of the spray is deposited on the undersides of leaves, where

rainfall is less apt to wash them off. Therefore, the use of drop nozzles for MH application is strongly discouraged. MH residues are often higher on lower leaves than on upper leaves because the lower leaves are harvested sooner after MH application. The MH label states that you should wait at least seven days between MH application and harvest, with the *anticipation that rainfall during this period will wash off some residues. If tobacco is ready for MH application and harvest, make every attempt to harvest first, then apply MH.* It will most likely be at least seven days before the crop will be ready for another harvest. This will assure MH-free first primings and minimal residues on the second primings.

MH is very water-soluble but is not substantially degraded by sunlight or the high temperatures used during curing. The data in Table 7-4 illustrate the importance of rainfall in reducing MH residues. In these tests, MH application was followed 24 hours later by various amounts of irrigation to simulate rainfall. Lower and upper green leaves were sampled for MH residues immediately after irrigation. Only 0.05 to 0.1 inch of irrigation significantly reduced MH residues on leaves from both stalk positions.

5. Consider using an alternative sucker control program. The most effective sucker control programs include proper use of the fatty alcohol contacts, flumetralin, and the labeled rate of MH. All of the newer programs provide better control than the traditional treatment of two contact applications followed by MH application (Table 7-5). These programs offer excellent, season-long sucker control without using more than the recommended rate of MH. The MH-flumetralin tank mix was used on more than 60 percent of the flue-cured acreage in 2002. The delayed use of flumetralin or another fatty alcohol application two to three weeks after MH involves an additional trip over the field but provides excellent late-season sucker control if applied before sucker buds exceed 1 inch in length. Apply the tank mix like a fatty alcohol contact, i.e., as a coarse spray (20 to 25 psi) using 50 gallons of spray volume per acre. *Do not use the delayed flumetralin application if flumetralin was used for sucker control earlier in the season.*

Time of MH Application

The systemic suckercide, maleic hydrazide, is the most widely used pesticide on tobacco grown in the United States. More recently, flumetralin, also a systemic suckercide, has become popular among flue-cured growers, particularly in tank mixes with MH. Each product controls sucker growth by inhibiting cell division. Most MH labels stipulate that it must not be applied before the upper leaves are 8 inches long to reduce possible stunting, a

discoloration called “bronzing,” or both. However, these abnormalities are sometimes observed when MH is applied on leaves longer than 8 inches. Growth distortion of upper leaves treated with flumetralin also occurs, but less frequently than that associated with MH. Since upper leaves are usually the most valuable on the plant, researchers at NC State University recently evaluated the effects of these two suckercides used alone or in tank mixes on upper leaf growth, yield, and quality, particularly when applications were early enough to cause upper leaf growth abnormalities.

Table 7-4. MH Residues on Lower and Upper Green Leaves Following Various Amounts of Irrigation, 1992-93

Irrigation Applied (inches)	MH Residues ^a (ppm)	
	Lower	Upper
None	61	181
0.005	53	125
0.01	51	96
0.05	32	85
0.1	27	84
0.2	22	76
0.5	24	70

^aAll treatments received 1.5 gal/a of MH. MH residues are averages of four experiments.

Table 7-5. Sucker Number and Weight Reductions with Sucker Control Programs Including Prime+, 1991-94

Application ^a		Suckers per Acre	
3rd	4th	(number)	(lb)
Ave. 25 On-farm Tests			
MH Alone	None	13,644	1,697
(MH & Prime +) Tank Mix	None	1,575	380
MH Alone	Prime+ (2 to 3 wks after MH)	557	165

^aThird applications preceded by 4% and 5% fatty alcohol contact applications. Rates were 1.5 gal/a for MH and 2 qts/a for Prime+.

A field study was conducted in eastern North Carolina from 1999 through 2001 using varieties NC 71 in 1999 and 2000 and K 326 in 2001. Several days following two applications of fatty alcohols, MH or Prime+ was applied alone or as a tank mix when tip leaf lengths averaged 11.5 to 12.5 inches. The same suckercide treatments were applied a week later on different plots when tip leaf lengths averaged 16.5 to 18 inches. Each suckercide was used at labeled rates in 1999 (1.5 gallons of MH and 0.5 gallon of Prime+ per acre), but higher rates of MH were also used in 2000 and 2001. The control treatment each year was four to six fatty alcohol applications plus several hand suckering as needed. Tip leaf lengths and widths were measured 18 to 24 hours before each systemic suckercide application and at least three more times until final harvest. Yield and quality of cured leaves were determined for the whole plant and also separately for the upper five leaves.

The treatment results and observations were similar each year. But the effects of MH on leaf growth and bronzing were more pronounced in 1999, when soil moisture was better and the plants were more succulent at the time the systemic suckercides were applied. The summary comments below are based on the average results shown in Table 7-6 for labeled rates of MH and/or Prime+ treatments common to each experiment of the study:

- The labeled rate of MH applied on 11.5- to 12.5-inch-long leaves reduced tip leaf growth and caused substantial bronzing of the upper four to five leaves. Both effects became apparent three to four weeks after MH application and, contrary to popular belief, upper leaves injured and bronzed by MH did not recover normal growth as the harvest season progressed. *However, Prime+ application on the shorter leaves did not stunt their growth, and the tank mix of Prime+ with MH was no more detrimental to leaf growth than MH applied alone. The undesirable effects associated with the labeled rate of MH were practically eliminated by delaying application until the following week when tip leaves were 16.5 to 18 inches long.* However, these effects were more pronounced when the MH rate was increased, and the double rate of MH caused some bronzing of upper leaves treated when the tip leaves were 16.5 to 18 inches long. *MH bronzing of the shorter leaves was noticeably and consistently reduced, however, when MH was tank mixed with Prime+.*
- MH residues on and in the upper five cured leaves were measured in two of the three experiments, both of which received substantial rainfall between application time and final harvest. The time of MH application did not substantially affect MH residues on and in upper leaves, and

residue levels were not closely associated with bronzing (i.e., residues were no higher for bronzed leaves treated when 11.5 to 12.5 inches long than for the normal-colored leaves treated a week later). *This implies that MH bronzing, which is traditionally associated primarily with excessive MH application, is also more pronounced when the labeled rate of MH is applied too early.*

- Whole-plant yield and grade index and the grade index of the upper five cured leaves were not consistently affected by when the systemic suckercides were applied. However, cured weights of the upper five leaves treated with Prime+ strongly tended to be higher than for those treated with MH. *In addition, cured weights were 5 to 8 percent higher when MH application was delayed until the tip leaves were 16.5 to 18 inches long.* Surprisingly, the same trend occurred with delayed application of Prime+ even though application of this systemic suckercide on the shorter upper leaves did not cause distortion or reduce their growth.

Table 7-6. Leaf Area, Cured Weight, and Grade Index of Upper Leaves Treated with Systemic Suckercides on Two Application Dates, 1999-2001 Experiments

Tip Leaf Length at Application (inches)	Tip Leaf Area 1-2 Wks Before Final Harvest (square inches)	Leaf Color Index ^a	Upper 5 Leaves	
			Cured Wt (lb/acre)	Grade Index
Contacts Only (Control)				
(4 - 6 Applic.)	133	41	723	58
Prime+ Alone, 0.5 gpa				
11.5 - 12.5	136	42	739	61
16.5 - 18	140	42	793	63
MH Alone, 1.5 gpa				
11.5 - 12.5	111	37	677	64
16.5 - 18	133	41	714	59
(Prime+ & MH) Tank Mix, 0.5 & 1.5 gpa				
11.5 - 12.5	114	34	661	61
16.5 -18	132	39	717	63

^aSPAD Meter readings taken five to six weeks after the first systemic suckercide applications in 2000 and 2001 experiments only; higher values indicate greener color or less bronzing.

These results indicate that even the labeled rate of MH (1.5 gallons per acre) applied on 11.5- to 12.5-inch-long leaves may discolor and irreversibly stunt their growth, particularly when the upper leaves are tender and succulent at application time. Higher rates of MH further increased leaf stunting and bronzing of similar-sized leaves, but tank mixing the labeled rate of MH with 0.5 gallon per acre of Prime+ was no more detrimental to leaf growth than the labeled rate of MH applied alone. *This study was not designed to identify a specific minimum upper leaf length required for safe MH application. But the results and observations imply that delaying MH application until tip leaves reach 15 to 16 inches long will substantially reduce the risk of upper leaf stunting, discoloration, and the possible weight loss observed in this study when only the labeled MH rate was applied on the shorter leaves.*

Topping and Chemical Sucker Control Programs

Several topping and chemical sucker control programs have been developed. Each is based on application of the correct rate of nitrogen (50 to 80 pounds per acre), depending upon soil type plus adjustments for leaching. *Excessive nitrogen availability promotes excessive sucker growth as well as leaf drop and breakage.* Proper sprayer calibration is important. See the sprayer calibration section in Chapter 6, “Weed Management,” for information on how to properly calibrate a sprayer boom with multiple nozzles per row.

Pay particular attention to label instructions regarding Worker Protection Standards (see Chapter 13, “Complying with the Worker Protection Standard”). This information provides specific requirements for personal protective clothing, restricted field reentry intervals, and other restrictions.

Program I (Overtop Application)

Step 1.

Apply an alcohol contact spray before topping when about 50 to 60 percent of the plants reach the button stage. The floral parts help to intercept sprays to increase sucker kill in the upper leaf axils. Use a 4 percent concentration for C₈-C₁₀ products or a 3 percent concentration for C₁₀ products. Using higher concentrations or application pressures than those suggested on the product labels may cause substantial leaf burn, particularly for C₁₀ products applied on tender tobacco when temperatures are unusually high.

Step 2.

Top plants that are ready for topping 24 to 48 hours after the first contact alcohol application, making sure to follow label instructions regarding reentry into pesticide-treated fields.

Step 3.

Make a second alcohol contact application three to five days after the first contact application. Use a 5 percent concentration for C₈-C₁₀ alcohols (2.5 gallons in 47.5 gallons of water per acre) or a 3 percent concentration for C₁₀ alcohols (1.5 gallons in 48.5 gallons of water per acre). Note: Drought-stressed fields or those with irregular growth and flowering may need a third alcohol contact application several days after the second, applied at the same concentration as the second application. An alternative for reasonably uniform fields with tip leaves at least 10 to 12 inches long is 0.5 gallon of flumetralin in 49.5 gallons of water per acre.

Step 4.

Top any plants that were not topped during the first topping.

Step 5.

Alternative A

Apply a tank mix of 1.5 gallons of MH (for products containing 1.5 pounds active MH per gallon) and 2 quarts of flumetralin per acre at the normal time for MH application. Apply as a coarse spray in 50 gallons of total solution per acre as with contact alcohols (three nozzles per row: TG3-TG5-TG3 or equivalents; see “Nozzle Sizes, Arrangements, and Application Speeds” below). *Use flumetralin only once per season to reduce the risk of soil residue carryover to following crops. Allow at least one week between MH application and harvest to minimize MH residues on and in cured leaves.*

Alternative B

Apply 3 gallons of FST-7 or Leven-38 in 47 gallons of water per acre about five to seven days after the second or third alcohol contact. Higher concentrations may cause leaf burn. Allow at least one week between MH application and harvest to minimize MH residues on and in cured tobacco. These products are a combination of a C₁₀ contact alcohol and MH but contain 11 percent less MH than other MH products when used at labeled rates.

Alternative C

Apply 1.5 gallons of MH per acre (for products containing 1.5 pounds active MH per gallon) about five to seven days after the second or third contact alcohol application. Allow at least one week between application and harvest to minimize MH residues on and in cured tobacco. MH alone

usually does not provide adequate season-long sucker control compared to the tank mix described in Alternative A, and a fourth application of one of the products in Step 6 below is often required to control late-season sucker regrowth.

Alternative D

Instead of the second or third (if applicable) contact alcohol application, apply 2 quarts of flumetralin per acre mixed in 49.5 gallons of water, as mentioned in Step 3, when the crop is at the elongated-button-to-early-flower stage. Apply by the dropline method or by tractor-mounted sprayer. With a tractor-mounted sprayer, apply as a coarse spray with low pressure just as you would for a contact application. About five to seven days after this application, apply the labeled rate of MH. Use flumetralin only once per season to reduce the risk of soil residue carryover to following crops. Allow at least one week between MH application and harvest to minimize MH residues on and in cured tobacco.

Step 6. *(Needed if sucker regrowth is anticipated late in the season)*

Alternative A

Apply a 5 percent C₈-C₁₀ contact solution (2.5 gallons in 47.5 gallons of water) using the standard application procedure for contact sprays. Do this about three weeks after MH application when suckers are small and susceptible to contact burn. Remove suckers longer than 1 inch by hand before application.

Alternative B

Apply 2 quarts of flumetralin per acre using the standard application procedure for fatty alcohol contacts (50 gallons of total solution per acre, three nozzles per row, low pressure). Apply about three weeks after MH application. Remove suckers longer than 1 inch by hand before application. Do not use this option if you applied flumetralin earlier in the season. Allow one week between MH application and harvest.

Program II (Hand or Dropline Application)

Alternative A

Apply flumetralin using the dropline method with 0.33 to 0.67 fluid ounce of solution per plant without using a contact solution. Prepare the flumetralin solution by mixing no more than 1 gallon of flumetralin in 49 gallons of water (2.5 fluid ounces of flumetralin per gallon of water). Start topping and hand suckering individual plants when approximately

50 percent of the plants are in the elongated-bud-to-early-flower stage. Treat topped plants with flumetralin at or within 24 hours after topping. As the remainder of the plants reach this stage, top them, remove large suckers, and treat the plants. Be careful not to treat previously treated plants or to use more solution than necessary to reach the bottom of the stalk.

Alternative B

Apply a contact solution at the button stage as in step 1 of Program I. When 50 percent of the plants reach the elongated-button-to-early-flower stage, apply flumetralin, preferably with the dropline method as in Alternative A, Program II; or use a power sprayer to apply 2 quarts of flumetralin in 50 gallons of water per acre. The purpose of the initial contact is to allow the smaller plants to become more mature before flumetralin is applied. However, spraying flumetralin may cause distortion of upper leaves less than 10 to 12 inches long. So you must decide whether to spray, use the dropline, or use another alternative in Program I based on the amount of unevenness in your crop.

Do not use surfactants with flumetralin because little, if any, enhanced control is obtained, and many surfactants are phytotoxic to tobacco.

Nozzle Sizes, Arrangements, and Application Speeds

Except for MH applied alone, all currently labeled suckercides and mixes must be applied by methods that encourage stalk rundown in order to be most effective. When using the standard three-nozzle arrangement (TG3-TG5-TG3), application speed is limited to 2.5 to 3 mph to maintain the spray volume over the center of the row. Application of fatty alcohols and contact-local systemics, including tank mixes of these products with MH, is one of the slowest mechanical operations in tobacco production except for transplanting and perhaps mechanical harvesting of first primings. The ability to apply these products faster without lowering sucker control reduces manual and machine labor, improves timeliness of suckercide application, and allows more acreage to be sprayed when the weather is favorable. The increasing use of more precise application equipment, such as “high-boy” sprayers, may allow many growers to apply suckercides faster without reducing sucker control.

In 10 field tests conducted in 1997 through 1999, a “high-boy” sprayer operated at 2.8 or 4.6 mph was used to apply each of several sucker control treatments shown in Table 7-7 (page 88) of *2001 Flue-Cured Tobacco Information*. All applications at 2.8 mph were made with standard TG3-TG5-

TG3 nozzles, and all applications at 4.6 mph were made with TG6-TG8-TG6 nozzles. Each combination of nozzle sizes and speeds delivered 50 gallons-per-acre spray volume per application on 48-inch rows. *Sucker number and weight per acre did not increase with any of the sucker control treatments when applied at the faster speed.*

In experiments conducted in 2001 and 2002, sprayer modifications were made that allowed the same treatments to be applied at 3 and 6 mph. In addition, a number of field experiments were conducted to determine if several other “straight” or “cross” nozzle arrangements with four or five nozzles per row would improve sucker control at the 6 mph application speed. Several of the arrangements are illustrated below. An additional purpose of the 5-8•8-5 and both of the five-nozzle-per-row arrangements was to concentrate relatively more of the total spray volume over the row centers as compared to the three-nozzles-per-row arrangements.

<u>3 Nozzles/Row</u>	<u>4 Nozzles/Row</u>	<u>5 Nozzles/Row</u>	
3—5—3	5—6•6—5	5	6
6—8—6	5—8•8—5		
		3—8—3	3—6—3
		5	6

The arrangements shown in Table 7-7 provided the best sucker control in these experiments. The differences in sucker number and weight among the three arrangements were not statistically different. The poorest performers on average were the five-nozzle-per-row arrangements, which concentrated a relatively higher percentage of the total spray volume over the row centers (data not shown). This implies that failure to keep these nozzle arrangements directly over the row may reduce sucker control relatively more than arrangements that supply more of the total spray to the sides of the row.

These results indicate that growers who wish to apply stalk rundown suckercides at faster speeds can do so with confidence if they have uniform row widths, good sprayer equipment, and relatively level land. However, relatively simple three- or four-nozzle-per-row arrangements appear to provide as good or better sucker control than the more elaborate five-nozzle arrangements tested to date.

No matter the arrangement you choose, be sure to calibrate your own application equipment for the row width, pressure, hose diameter, and

strainer sizes to be used. Instructions for calibrating a sucker control boom are given in Chapter 6, “Weed Management.” After determining the output in gallons per minute (gpm), the speed needed to deliver the appropriate number of gallons of spray volume per acre (e.g., gpa = 50 gal/a) can be calculated by using the following formula:

$$\text{mph} = (\text{gpm} \times 5,940) / (\text{gpa} \times \text{row width (inches)})$$

Table 7-7. Sucker Numbers and Weights per Acre in Nine Experiments for a Good Sucker Control Program Applied with Three Nozzle Arrangements and/or Sizes, 2001-2002

TG Nozzle Sizes (per row)	Gauge Pressure (psi)	Applic. Speed ^a (mph)	Suckers per Acre ^b	
			(number)	(lb)
C(4%) + C(5%) + (MH & Prime+) ^c				
3—5—3	20	3	1,089	288
6—8—6	18	6	1,480	395
5—6•6—5	18	6	1,477	346

^aEach speed delivers 50 gal/a of spray volume for the nozzle sizes and gauge pressures shown.

^bAverages of nine research and on-farm tests.

^cRates were 2 qt/a Prime+ and 1.5 gal/a MH.

2004 On-Farm Test Results

The average results of sucker control tests conducted at three locations are shown in Table 7-8. Suckers longer than 1 inch were removed by hand just before application of the first fatty alcohol contact, and no further suckering was done until sucker number and weights for the various treatments were recorded after the final harvest. The higher the number and weight of suckers per acre, the *poorer* the control. All applications were made with a “high-boy” sprayer similar to that used on many farms.

1. Sucker pressure was moderate to heavy in 2004 due to dry conditions mid-season. Although late-season rainfall was above normal statewide, the harvest season was lengthened, which increased late-season sucker pressure. Treatments involving tank mixtures of the labeled rate of MH with a product containing flumetralin provided better sucker control than MH alone as a third application. Sucker number per acre was high for treatments involving MH alone (liquid or water-soluble) following two contacts, but the sucker weights were low. High sucker number and low

sucker weight indicate small suckers, which typically would not cause a problem during harvesting and curing.

2. The most common treatment among growers (two alcohol contacts followed by a tank mix of MH and a product containing flumetralin) provided better sucker control than most other treatments. Applying a contact or a product containing flumetralin at the third application and delaying the MH application did not greatly improve sucker control.

Products containing flumetralin can be successfully tank mixed with water-soluble MH products, which have performed as well as liquid MH formulations in previous years. Using water-soluble MH products can reduce your pesticide container disposal problem.

Growers who continue to obtain poor sucker control with programs involving only fatty alcohol contacts and MH (liquid or water-soluble) should consider using a product containing flumetralin in a tank mix with MH for a third or fourth application following two to three applications of fatty alcohol contacts.

PRECAUTIONARY STATEMENT ON PESTICIDES

Pesticides must be used carefully to protect against human injury and harm to the environment. Diagnose your pest problem and select the proper pesticide if one is needed. Follow label use directions, and obey all federal, state, and local pesticide laws and regulations.

Table 7-8. Average Sucker Control Results from Tests Conducted in Alamance, Greene, and Wake Counties in 2004

Button (1 st appl.)	Time of Application			Suckers/ Acre	Wt./Sucker	
	3-5 days (2 nd appl.)	5-7 days (3 rd appl.)	5-7 days (4 th appl.)	(number)	(lb)	(lb)
OST 2 gal	OST 2.5 gal	(RMH 1.5 gal & P+ 0.5 gal)	—	1,050	283	0.27
RTM 2 gal	RTM 2.5 gal	RMH 1.5 gal	—	4,000	668	0.17
RTM 2 gal	RTM 2.5 gal	RMH 2.0 gal	—	2,475	308	0.12
RTM 2 gal	RTM 2.5 gal	(RMH 1.5 gal & FLUPRO 0.5 gal)	—	1,350	301	0.22
RTM 2 gal	RTM 2.5 gal	P+ 0.5 gal	—	3,200	1,063	0.33
RTM 2 gal	RTM 2.5 gal	FLUPRO 0.5 gal	—	3,025	1,031	0.34
ANTAK 1.5 gal	ANTAK 1.5 gal	Leven-38 3.4 gal	ANTAK 1.5 gal	1,175	200	0.17
SP 2 gal	SP 2.5 gal	SUCKER STUFF 80 WS 3.75 lb	P+ 0.5 gal	1,375	289	0.21
FAIR 85 2 gal	FAIR 85 2.5 gal	(FST-7 3.0 gal & P+ 0.5 gal)	—	600	103	0.17
FAIR 85 2 gal	FAIR 85 2.5 gal	FAIR 85 2.5 gal	FAIR 80 WS 3.75 lb & P+ 0.5 gal	1,442	292	0.20
OST 2 gal	OST 2.5 gal	P+ 0.5 gal	RMH 1.5 gal	1,200	294	0.25
OST 2 gal	OST 2.5 gal	(RMH 2.0 gal & P+ 0.5 gal)	—	675	131	0.19

All spray app□

volume using a “high-boy” sprayer.

(Parentheses) indicate a tank mix; OST = Off-Shoot T, RTM = Royaltac M, SP = Sucker Plucker, P+ = Prime+, RMH = Royal MH-30.

Table 7-9. Chemical Control of Sucker Growth

Chemical and Formulation	Purpose	Amount of Formulation Per Acre	Precautions and Remarks
<p>CONTACT TYPE C_8-C_{10} fatty alcohol (various brands) 6.01 lb/gal</p> <p>C_{10} fatty alcohol 5.72 lb/gal</p>	Normal sucker control	<p>2 or 2.5 gal (4% or 5%)</p> <p>1.5 gal (3%)</p>	<p>Apply in 48 gal of water per acre (4% solution) to plants in button stage with second application 3 to 5 days later at any time of the day, except when plants are wet or temperature exceeds 90°F. Use two TG-3 nozzle tips plus a TG-5 in the center or equivalents per row with approximately 20 psi operated from 12 to 16 in. above the top of the button or stalk at 2.5 to 3 mph. Rate of second application may be increased to 2.5 gal in 47.5 gal of water (5% solution) unless crop is tender. Will not control suckers more than 1 in. long. Excess nitrogen increases the chance of leaf drop.</p> <p>Apply in 48.5 gal water per acre (3% solution) for both applications. Follow application instructions above for C_8-C_{10} alcohol.</p>
<p>CONTACT TYPE C_8-C_{10} fatty alcohol 6.01 lb/gal</p>	Control of late-season sucker regrowth	2.5 gal (5%)	Apply 3 to 4 weeks after MH application if control is starting to break down. Apply in 47.5 gal of water per acre. Follow same directions as above. Will not control suckers more than 1 in. long. Do not make more than three applications of a contact per crop per season.
<p>SYSTEMIC TYPE (Maleic hydrazide [MH]) Liquids, various brands</p> <p>1.5 lb/gal</p> <p>2.25 lb/gal</p> <p>60% Water-Soluble Products Fair 80 SP or Sucker Stuff 60 WS</p> <p>Royal MH-30 SG</p>	Normal sucker control	<p>1.5 gal (1 qt/1,000 plants)</p> <p>1 gal (1 qt/1,500 plants)</p> <p>3.75 lb</p> <p>4 to 5 lb</p>	<p>Rate varies with plant population. 1.5 gal of the 1.5 lb per gal material assumes 6,000 plants per acre. For plant populations other than 6,000, adjust rate accordingly. Apply to plants 5 to 7 days after the last contact application. Apply in the morning, using 30 to 50 gal of water per acre, two to three cone nozzle tips per row, and 40 to 60 psi. Effectiveness will be reduced if applied to wet plants or those that are drought stressed or wilted from too much rainfall or high temperatures. Do not make more than one application per season. Should wash-off occur within 6 hr, a single repeat application may be made. DO NOT APPLY AT HIGHER THAN SUGGESTED RATES OR WITHIN 7 DAYS BEFORE HARVEST IN ORDER TO MINIMIZE MH RESIDUES.</p> <p>Rate for 6,000 plants per acre. Adjust rate accordingly for other plant populations.</p>

Table 7- 9. (continued)

Chemical and Formulation	Purpose	Amount of Formulation Per Acre	Precautions and Remarks
CONTACT, LOCAL-SYSTEMIC TYPE flumetralin (Prime+ or Flupro) 1.2 lb/gal	Normal sucker control, power sprayer	2 qt	Mix in 49 gal of water per acre and apply as a contact at elongated button to early flower stage with three nozzles per row (TG-3, TG-5, TG-3). Remove suckers longer than 1 in. within 24 hr before application and remove missed suckers as observed later. Excess spray to the point of rundown on the soil increases the risk of carryover residues, which may stunt early growth of next crop, including tobacco if a dinitroaniline herbicide is also used. Do not apply these products through any type of irrigation system, and apply only once per season. Rainfall within 2 hr after application may reduce effectiveness. Follow WPS requirements and other precautions and restrictions listed on product labels.
flumetralin (Prime + or Flupro) 1.2 lb/gal	Hand application	1.2 to 2.4 qt (2.5 oz/gal water)	Mix in desired amount of water at rates shown in parentheses and apply mixture as a coarse spray or drench to top of stalk. Apply about 0.5 oz of mixture per plant after topping and removing suckers longer than 1 in., but do not exceed 25 to 30 gal per acre. Apply only once per plant per season. See remarks above for power sprayer application and follow precautions, restrictions, and WPS requirements shown on product labels.
flumetralin (Prime + or Flupro) 1.2 lb/gal	Control of late season sucker regrowth	2 qt	Apply only if control with MH is beginning to break down. Mix in 49 gal water per acre and apply as a contact at 20 to 25 psi 3 to 4 weeks after MH application; will not control suckers longer than 1 in. TO REDUCE THE RISK OF SOIL RESIDUE CARRYOVER, DO NOT USE FOR LATE-SEASON CONTROL IF USED EARLIER IN THE SEASON.
SYSTEMIC TYPE maleic hydrazide (MH) + CONTACT, LOCAL-SYSTEMIC TYPE flumetralin (Prime+ or Flupro)	Normal sucker control	Full rate MH + 2 qt	See precautions and remarks for MH to determine “full rate” of MH. Mix in sufficient water to total 50 gal per acre, and apply 5 to 7 days after the last contact or when MH alone is normally applied. Apply as a contact, using three nozzles (TG-3, TG-5, TG-3) per row with 20 to 25 psi. Follow precautions and restrictions on labels. DO NOT APPLY AT HIGHER THAN LABELED RATES OR WITHIN 7 DAYS BEFORE HARVEST IN ORDER TO REDUCE MH RESIDUES.

Table 7- 9. (continued)

Chemical and Formulation	Purpose	Amount of Formulation Per Acre	Precautions and Remarks
CONTACT-SYSTEMIC TYPE C ₁₀ fatty alcohol + MH (FST-7 or Leven-38) 4 lb/gal	Normal sucker control	3 gal	Apply in 47 gal water to plants in early flower stage (1 week after button) any time during the day except when plants are wet or temperatures exceed 90°F. Use three nozzles per row with tips that deliver a coarse spray and desired rate when operated at 20 psi. Operate sprayer at a speed of 2.5 to 3 miles per hour and spray 50 gal of diluted emulsion per acre. Use a semi-coarse spray covering the top 1/3 to 1/2 of the plant and allowing the liquid to run down the stalk to the bottom of each plant. DO NOT APPLY AT HIGHER THAN SUGGESTED RATES OR WITHIN 7 DAYS BEFORE HARVEST IN ORDER TO MINIMIZE MH RESIDUES. Effectiveness will be reduced if applied to plants that are drought-stressed or wilted from too much rainfall or high temperatures.

Use of Ethephon

Ethephon (Prep, Ethephon 6, Mature XL, or Super Boll) is the only chemical approved for yellowing tobacco in the field. To use any other chemical for this purpose is illegal. Growers who do so—whether selling by contract or at auction—could cause considerable problems for themselves, as well as our industry.

Before spraying whole fields of tobacco with ethephon, test-spray some plants uniformly with hand kits available from agricultural chemical dealers, or prepare your own test-spray by mixing 1 teaspoon of product in 1 quart of water. The purpose of test spraying is to determine whether the leaves are mature enough to be induced to yellow. Test-spraying a few representative plants at several locations in each field and observing them two to three days later will help you decide if the tobacco will yellow as desired. This may be especially important in fields planted at different times or to different varieties, fertilized differently, topped at different heights, or otherwise managed differently. *Ethephon should be used on the entire field only if plants respond well to test-spraying; if test leaves do not yellow within 72 hours, the crop is not mature enough to be sprayed or harvested.*

Good spray coverage, especially of the leaf butts and uppermost leaves, is essential to achieve uniform yellowing. For over-top applications, apply the chemical in 50 gallons of spray per acre using a three-nozzle arrangement at a pressure of 40 to 60 psi. The finer the spray, the better the chance of it drifting inward toward the stalk and covering the leaf butts; consequently, 60 psi may give better coverage than 40 psi. Be sure to adjust the nozzles to ensure adequate coverage of all remaining leaves. *Ethephon works more consistently when applied on warm, sunny days. Treat only the acreage that can be harvested in one day, and guard against leaf drop by not allowing treated tobacco to become overyellow before harvesting. Each of the four products listed above contains 6 pounds of ethephon per gallon and is labeled to be used at 1½ to 2⅔ pints per acre. Use the lower rate for normal crops and the higher rate for rank crops, particularly when temperatures are lower than normal at application time.*

The field reentry time restriction for ethephon is 48 hours after application. Also, allowing 48 hours between spraying of ethephon and harvesting results in larger and more consistent reductions in curing time compared to earlier harvesting. (See results of curing tests shown on page 93 of *2001 Flue-Cured Tobacco Information*.)

Table 7-10. Yellowing Agents for Flue-cured Tobacco

Purpose	Chemical	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
To increase the rate of yellowing	ethephon (Prep) (Super Boll) (Mature XL)	1.33 to 2.67 pt	1 to 2 lb	Use after second or third priming when remaining leaves are physiologically mature. Determine if field is ready to spray by treating several representative plants at several locations with test kit (or prepare test spray by mixing 1 tsp of product in 1 qt of water). If test leaves begin to yellow in 24 to 72 hr, apply product to field in 40 to 60 gal water per acre as a fine spray mist (40 to 60 psi). Effectiveness may be reduced by application on cool, cloudy days, poor spray coverage, or rain within 4 hr after application. Harvest leaves within 24 to 48 hr or when they reach the desired degree of yellowness; prolonged delay in harvest may result in yield and quality loss or leaf drop. Therefore, do not spray more acreage than can be harvested before major rain is expected. DO NOT USE SURFACTANTS!