HANDBOOK ON

# THE CULTURE OF MARYLAND TOBACCO

TENTH EDITION

MARYLAND TOBACCO IMPROVEMENT FOUNDATION, INC.

# HANDBOOK ON THE

# CULTURE OF MARYLAND TOBACCO

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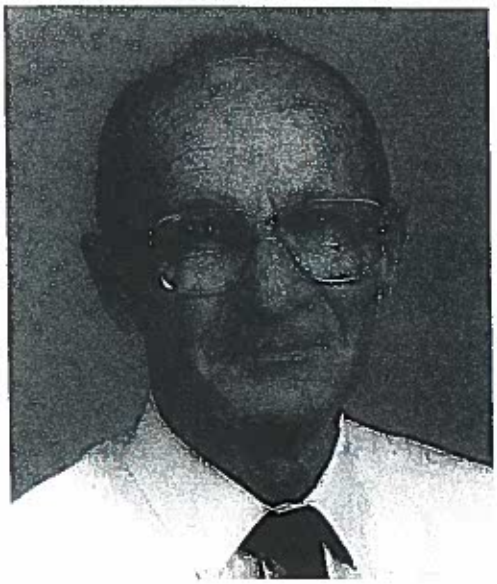

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The tenth edition is dedicated to the memory of Dr. Claude G. McKee
for 44 years of dedicated service to Maryland's tobacco industry.
1930 - 1998

## NOTICE ABOUT CHEMICALS

The chemicals recommended in this handbook are those that were permitted for use on Maryland tobacco at the time of publication. This situation is constantly changing, therefore, for the latest information on chemicals labeled for use on Maryland tobacco, contact your local Maryland Cooperative Extension Office and Extension Agricultural Educator.

### Using and Handling Chemicals

**All agricultural chemicals have toxicity signal words and symbols. The following information on signal word categories is from the Maryland Pesticide Applicator Training Series Core Manual published by the University of Maryland Cooperative Extension.**

**DANGER/POISON** and a skull-and-crossbones symbol appear on the label of all products that are highly toxic orally, dermally, or by inhalation. If the product is corrosive to the eyes or skin, but is not considered highly toxic, only the signal word **DANGER** is required. Ingesting as little as a taste to one teaspoonful of one of these pesticides could kill an average adult.

**WARNING** is the signal word required on the labels of all products that are moderately toxic orally, dermally or by inhalation, or that cause moderate eye and skin irritation. A teaspoonful to a tablespoonful by mouth could kill an average adult.

**CAUTION** is the signal word required on the labels of all products considered slightly toxic to relatively non-toxic orally, dermally or by inhalation, or that cause slight eye and skin irritation. An average adult could be killed by ingesting an ounce to more than a pint of one of these pesticides.

**READ THE LABEL AND**

**FOLLOW MANUFACTURERS DIRECTIONS**

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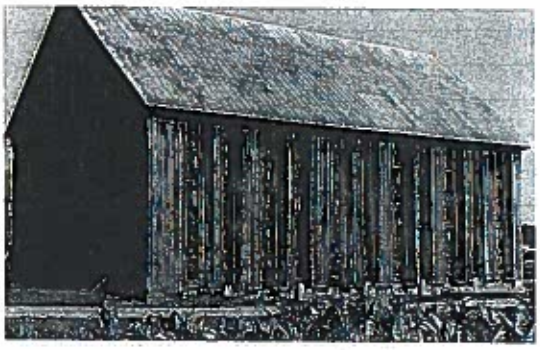


## INTRODUCTION

This handbook is made possible because of the demand for high quality Maryland tobacco leaf by the inhabitants of Europe.

Each year most of the better quality Maryland tobacco is purchased by European cigarette manufacturers. This tobacco is used in the manufacture of Maryland cigarettes, which are made of the very best Maryland tobacco to which is added a small percentage of neutral and very mild European tobaccos to round out flavor. No artificial flavorings or casings are added in the manufacture of many of these cigarettes. Therefore, the manufacturers depend on the quality of the Maryland tobacco for the quality of their cigarettes. If this tobacco is good the quality of the cigarettes will be good. If the European manufacturers cannot buy enough choice Maryland tobacco the quality of their cigarettes must deteriorate. This is very dangerous to the European manufacturers as well as the Maryland growers for the following reason. If the quality of the Maryland tobacco and therefore Maryland cigarettes is not satisfactory, the smoker can shift to one of the other types. It is therefore in the mutual interest of the Maryland tobacco growers and the European manufacturers of Maryland cigarettes to make all possible efforts to grow a sufficient supply of high quality Maryland tobacco in order to satisfy the European smoker who up to now prefers the Maryland cigarette to any other type.

Some years there has not been enough of the high quality Maryland tobacco to satisfy the European demand. In order to help insure an adequate supply of the high quality Maryland tobacco, the European cigarette manufacturers together with their American tobacco dealers are supporting the Maryland Tobacco Improvement Foundation, Inc., in its programs of research, extension, and free seed distribution. Through many years of patient research, on the part of the University of Maryland, the U.S.D.A., and the Foundation, much information is now available on how to grow high quality Maryland tobacco under acceptable yield conditions. The Foundation is at the disposal of the Maryland tobacco growers to supply them with information to help them grow high quality tobacco. Some of this information is published on the following pages of this handbook. The European manufacturers hope, by dedicating this book to their friends, the Maryland tobacco growers that it will help in their mutual interest to bring more fine tobacco leaf to the market.

The European manufacturers know that a good crop is not only a result of careful growing and careful handling, but also of appropriate weather conditions. However, the farmer that does a good job of management all the time will get the best average result. When the weather conditions are favorable he will be able to market a crop of tobacco that will sell at top prices, and then be shipped to Europe to give a lot of smoking pleasure to all the friends of Maryland cigarettes.

**Section I**

## TOBACCO VARIETIES

### Maryland 609

Maryland 609 (MD 609) is the most popular variety of Maryland tobacco. It was released in 1965 because of its resistance to the diseases black shank (*Phytophthora parasitica var. nicotianae*) and fusarium wilt (*Fusarium oxysporum f. sp. nicotianae*). Normally, MD 609 matures 7 to 10 days later than the older MD 10 type. It should be fertilized in the 70 to 90 pound nitrogen range. MD 609 grows very rapidly in the seedbed, but after transplanting it often appears uneven in early field growth. It tends to "even up" at topping time and should be topped in the early to medium bloom stage. MD 609 grows with a lighter green color than other varieties, and this color should not be confused with ripeness. Allow this variety to ripen at least two weeks after topping before harvest. MD 609 does not tend to fire quickly, but some leaf loss has occurred from air pollution.

At harvest, MD 609 is somewhat brittle and slow to wilt. Growers report that this variety does not "hurt" in the barn as fast as other varieties. It produces a very high quality cured leaf of light reddish color and is considered easy to strip.

The major grower criticisms of MD 609 are:

1) The variety will blow down easily in windstorms.
2) The leaves are brittle and some breakage occurs at harvest.
3) The stripped tobacco is difficult to dry out for packing in some seasons. This is even more noticeable with the use of sucker control chemicals. Excessive use of nitrogen and/or sucker control chemicals and delaying harvest all tends to aggravate this situation.

### Maryland 601

Maryland 601 (MD 601) was released in 1999 for production in 2000. It was derived by crossing MD 341 with MD 609 followed by 7 backcrosses with MD 609 and then selfed for several generations to stabilize the variety. MD 601 has resistance to tobacco mosaic virus, wildfire (*Pseudomonas syringae* pv. *tabaci*), and black shank. It has long leaves that are medium to broad in width with pointed tips. Growth after transplanting appears to be relatively rapid and uniform with a spreading growth habit. As the plants reach maturity, the leaves develop a slightly droopy appearance. The variety appears to maintain a slightly darker green color than MD 609 during the growing season.

Plant and chemical characteristics evaluated prior to this variety's release showed MD 601 had similar characteristics to all available varieties. Burn time was good, quality index ratings were high, and the variety cured with a high percentage of desirable leaf colors (L, F, R).

Management practices for MD 601 should be similar to those used in the production of MD 609. It appears this variety wilts faster and is not as brittle during harvest. Cured leaf colors lean towards the lighter side of the acceptable color spectrum.

Maryland 402

Maryland 402 (MD 402) was also released in 1999 for production in 2000. It was derived by crossing the A911 breeding line (F7 generation of a MD 872 x MD 201 cross) with MD 609, followed by one backcross with MD 609 and then selfed for several generations to stabilize the variety. MD 402 also has resistance to tobacco mosaic virus, wildfire, and black shank. Like MD 601, it has long leaves that are medium to broad in width with pointed tips. Growth after transplanting appears to be rapid and uniform with a spreading growth habit. As the plants reach maturity, the leaves develop a slightly droopy appearance. In the field this variety appears to maintain a slightly darker green color than MD 609 and MD 601.

Plant and chemical characteristics evaluated prior to this variety's release showed MD 402 had similar characteristics to all available varieties. Burn time was excellent, quality index ratings were the highest when compared to all available varieties, and the variety cured with a high percentage of desirable leaf colors (L, F, R).

Management practices for MD 402 are similar to those used in the production of MD 609. The variety wilts faster like MD 601 and is not as brittle during harvest. Cured leaf colors are darker than MD 601 and lean towards the darker side of the acceptable color spectrum.

Maryland 341

Maryland 341 (MD 341) was developed from a series of crosses of MD 10 and MD 64 type breeding lines. This variety is resistant to both tobacco mosaic virus and wildfire diseases. It is not resistant to black shank.

MD 341 appears to be quite similar to other varieties as far as management practices are concerned. It appears to grow-off rapidly and evenly in the field. The field appearance is similar to MD 201 with long leaves that are medium in width and have a pointed tip. Maturity is about mid-range, similar to MD 40. It should be topped at early flower and allowed to mature at least 2 weeks before harvest. General observations are that this variety wilts quicker than MD 609 and is less bushy to handle than older MD 872. Stalk size under favorable conditions can be big. MD 341 should be given adequate barn room to permit good air circulation as with our other varieties under present production levels.

The cured leaf of MD 341 is normally on the reddish side of color, but some tan to yellowish color can develop under adverse growing or curing conditions.

Maryland 201

Maryland 201 (MD 201) was developed from a cross of MD 64 and an early generation MD 10 breeding line. It is a slow growing, slow maturing variety. Leaves are long, medium-to-broad width with a pointed tip and relatively "close set" on the stalk. MD 201 is resistant to tobacco mosaic virus.

MD 201 should be fertilized in the 70 to 90 pound nitrogen range with the higher rates on sandier soils. Early growth in the fields is quite "spready". The plants should be topped at the early to medium bloom stage. Topping level should be on the low side to avoid a lot of small leaves at the top of the stalk. Allow the plants to ripen at least two weeks before harvest. MD 201 has shown good wind resistance in field tests during later stages of growth.

The handling characteristics of MD 201 at harvest are similar to MD 10. It should be given ample barn room because it also tends to "clam" like MD 10. The cured leaf of MD 201 is more of a brownish color.

Maryland 40

Maryland 40 (MD 40) was released to growers for the 1993 growing season. It was developed by an initial cross of MD 872 and MD 201. A breeding line was selected from this cross and crossed with MD 609. The total time in development was 11 years. The resulting variety is resistant to wildfire, tobacco mosaic virus, and has a very high tolerance to black shank - the first Maryland variety with this combination of disease resistance and tolerance.

MD 40 appears to grow very well in the seedbed. Growth after transplanting is both rapid and uniform. It has a spready growth habit and relatively large leaves. The plants are not as brittle as MD 609 and wilt faster at harvest like MD 201 and MD 341. MD 40 has a better root system than MD 609, thus lodging is less of a problem than with MD 609. The cured leaf of MD 40 normally has a good Maryland color, but under adverse curing conditions can develop the lighter shade colors.

MD 40 gives growers with a moderate black shank problem another option than MD 609. This variety also has wildfire and tobacco mosaic virus resistance giving genetic protection for 3 disease problems.

Free Tobacco Seed

The Maryland Tobacco Improvement Foundation, Inc. makes available to the tobacco growers of Maryland free raw and pelletized seed of the recommended varieties. This seed is available through the five Southern Maryland County Extension Offices and the Central Maryland Research & Education Center, Upper Marlboro Facility. It is recommended that you make use of this seed of known purity and germination.

If you are going to grow a new variety for the first time, plant only a limited amount the first year. This will enable you to observe and evaluate the variety under the conditions on your farm.

**Table 1**
**Average Performance of Maryland Tobacco Varieties over 6 Years, 1991 to 1996**

| Variety | Pounds/Acre | Price/Pound | Value/Acre | Quality Index |
|---|---|---|---|---|
| MD 609 | 1,859 | 1.54 | 2,887 | 56.4 |
| MD 601 | 1,812 | 1.55 | 2,820 | 60.0 |
| MD 402 | 1,863 | 1.56 | 2,917 | 60.8 |
| MD 341 | 1,966 | 1.50 | 2,969 | 49.5 |
| MD 201 | 1,951 | 1.51 | 2,984 | 50.2 |
| MD 40 | 1,826 | 1.52 | 2,796 | 49.3 |
| | | | | |
| Average | 1,880 | 1.53 | 2,896 | 54.4 |

**Table 2**
**Plant and Chemical Characteristics of Maryland Tobacco Varieties, 1991 to 1996**

| Variety | Plant Height (Inches) | Leaves/ Plant | Days To Flower | Burn Time (sec/leaf) | Total Alkaloids (%) | Total Nitrogen (%) |
|---|---|---|---|---|---|---|
| MD 609 | 29.7 | 19.0 | 63.1 | 11.4 | 3.06 | 3.55 |
| MD 601 | 30.1 | 18.8 | 63.5 | 10.7 | 3.16 | 3.63 |
| MD 402 | 28.9 | 18.9 | 63.4 | 13.0 | 2.81 | 3.62 |
| MD 341 | 29.9 | 20.7 | 60.4 | 11.0 | 2.96 | 3.34 |
| MD 201 | 28.8 | 20.1 | 62.9 | 8.3 | 3.07 | 3.31 |
| MD 40 | 31.2 | 19.0 | 63.2 | 10.8 | 3.32 | 3.48 |
| | | | | | | |
| Average | 29.8 | 19.4 | 62.7 | 10.9 | 3.06 | 3.49 |

**Table 3**
**Disease Resistance of Maryland Tobacco Varieties**

| Variety | Tobacco Mosaic Virus | Wildfire | Black Shank |
|---|---|---|---|
| MD 609 | Susceptible | Susceptible | Resistant |
| MD 601 | Resistant | Resistant | Resistant |
| MD 402 | Resistant | Resistant | Resistant |
| MD 341 | Resistant | Resistant | Susceptible |
| MD 201 | Resistant | Susceptible | Susceptible |
| MD 40 | Resistant | Resistant | High Tolerance |


Newest Releases of Maryland Tobacco Cultivars MD 402 and MD 601

Section II

## TRADITIONAL TOBACCO BEDS

### Size of Traditional Tobacco Beds

Maryland farmers have traditionally used 4 yd. x 25 yd. and 5 yd. x 20 yd. sized beds. These bed sizes are all wide compared to those in use in other areas. A large percentage of seedbeds in the flue-cured area are no more than 6 feet wide. Narrow beds have some definite advantages in that there is less stepping into the bed area. These sizes are also better adapted for treatment with chemical soil injection and plastic cover laying equipment. They are also better adapted for clipping and undercutting practices. Covers are available from manufacturers in the narrow widths.

### Factors To Consider in Locating Tobacco Beds

- Availability to water – natural rainfall is not enough, therefore, watering of beds is a must. Locating your beds near water will cut down on labor and equipment for watering.

- Soil – Locate your beds on a well drained soil that will warm up early in the spring. Soil provides the plant with support for the roots, water, and plant food; therefore, your soil should be of proper tilth for root penetration and good aeration. Proper fertilizer applications can correct nutrient deficiencies.

- Drainage – A slight slope is desirable for drainage, but too much slope will favor erosion. Ditching or bedding may be necessary to get the desired drainage on level sites. Run-off water crossing beds can spread some diseases.

- Protection from wind – Buildings, trees, slopes, and windbreaks will serve to prevent loss of seed and excessive drying of beds. Tobacco seedling failures in many instances can be attributed to lack of soil moisture (due to winds, etc.) and are further aggravated by lack of watering.

- Convenience – A location convenient to the house is preferred. A bed in a remote location does not have the advantage of regular inspection for insects, disease, drying out, and other damage so costly to newly germinated plants.

- Disease free – The bed site should have a disease free history. Old bed sites and tobacco fields should be used with caution as diseases of tobacco such as root rot, wildfire, mosaic, black shank, etc., can remain in the soil and on old plants and weeds in the area.

- Herbicide free – Avoid putting tobacco beds in areas that have had non-tobacco herbicides applied that season or where possible spills or high dosages have occurred in previous years. Also avoid being downgrade from fields that have had non-tobacco herbicides applied to them in the spring and possible washing could occur.

**Soil Test**

A soil test of your plant bed site can help detect possible problems before they occur. Both high pH levels and low magnesium levels can cause problems and will be detected with a soil test. The pH range for tobacco beds should be between 5.0 and 5.6. There is danger of black root rot (*Thielaviopsis basicola)* when the pH is above 5.6. Low magnesium levels can cause magnesium deficiency in the young seedlings. If pH levels are not too high, this can be corrected with high magnesium lime.

Plan ahead when a new area is being considered for plant production. Soil test the new area you are considering for plant beds in the early fall prior to sterilization.

**Fertilizing Tobacco Beds** – the following serves as a guideline for fertilization practices for tobacco transplant production.

- Initial application - Either 4-8-12 or 7-7-7 tobacco grade fertilizer is used for tobacco beds at the general rate of 30 to 50 pounds per 100 square yard bed. This amount is varied depending on the soil type and soil test. Fertilizer may be applied in the spring or fall – preferably in the fall, as burning of plants may result when applied in the spring. Use the lower rate for spring application. Use only tobacco grade fertilizers on your seedbeds (absent of muriate of potash). Other fertilizer types contain chlorine and can cause chlorine injury to plants.

- Topdressing – It is often necessary to apply extra nitrogen and magnesium to young plants to keep them growing properly. If either or both are lacking, the plants will cease to grow and develop characteristic deficiency symptoms.

- Magnesium (Mg) – The deficiency shows up as a light yellow coloring between the veins of the leaf with the veins remaining green. This can be corrected by applying 4 pounds of Epsom salts per 100 square yards and follow with a good watering.

- Nitrogen (N) – The deficiency shows up as a light yellow coat over the whole leaf. This can be corrected by applying 2 pounds of nitrate of soda, 1 pound of ammonium nitrate, or equivalent per 100 square yards and follow with a good watering.

- Topdressing treatments can be repeated if necessary. Careful consideration must be given towards the application of additional fertilizers when needed so as not to cause burning of young succulent stems and scorching of leaves. After application always follow with a good watering.

## Organic Matter

The use of sludge origin organic fertilizers is not recommended for tobacco plant beds. The uncontrolled release of ammonia can cause burning of plant tissue. The controlled availability of the nitrogen fertilizer component is also in question.

The addition of organic matter will improve the condition of most tobacco plant beds. Peat is the most commonly used source of organic matter. Use 6 to 8 cubic feet of peat per bed and rake into the surface.

## Weed Control

Time and money are well spent in proper weed control methods. The best time for such treatments is in the early fall when soil moisture is satisfactory and soil temperature is above 50 degrees F. The bed area should be prepared into a loose friable condition before using any of the following soil sterilants or herbicides.

METHYL BROMIDE (Gas) – **Methyl bromide will not be available in the near future**. Due to the Montreal Protocol Treaty, its use in the United States is being phased out through the year 2005. Although the extension of this phase out period is possible, long-term availability is doubtful.

This is a Restricted Use Chemical (RUP) that must be purchased by a certified private pesticide applicator. It is the most widely used method and one of the surest. A gas tight plastic fumigation cover and special tray applicator used to open the can is necessary. The product can be used both in the fall and spring. However, for best performance growers' are urged to apply this gas in the fall and leave the fumigation covers on the treated area throughout the entire winter period. Grower's time in the spring is busy and the scheduling for spring fumigation is often delayed by wet and cool weather. By leaving the fumigation covers on over the winter, early removal of covers allows for spring drying and immediate seeding after a 48-hour ventilation period.

1) Soil temperature – should be at least 50 degrees F., preferably 60 degrees F.
2) Rate – 1 pound per 100 square feet or 6 - 1 ½ pound cans per 100 square yard bed.
3) Time required – allow the cover to stay on 24 hours if the temperature is 60 degrees and above, and 48 hours if the soil temperature is between 50 and 60 degrees.
4) Waiting time before seeding – under normal conditions allow one day after removal of cover to seed the beds.

Methyl bromide can also be custom applied with soil injection equipment and plastic cover applicators. The availability of individuals certified for the commercial application of fumigants limits the use of this technique in the Maryland area.

- VAPAM HL (*Metam Sodium)* – The 32.7% anhydrous formulation is a Restricted Use Product. The 42% anhydrous product does not carry RUP classification, although, it is identified with the DANGER signal word. This is a liquid drench type material that is mixed with water and applied to the bed. Prepare the bed 5 to 7 days before application to insure best conditions for weed seed germination and fumigant action. The bed should be free of clods, level, and in good tilth. Apply 0.75 to 1.125 gallons in a minimum of 30 gallons of water per 100 square yards. Apply uniformly over the entire bed. Cover the bed immediately with a plastic fumigation cover. This method is preferred to the drench method of 1.875 gallons per 100 square yard bed. Vapam has very detailed instructions in the label booklet about application procedures. It is very important to read and follow the instructions carefully. Vapam should only be used for Maryland tobacco with fall application.

  Vapam can also be applied with soil injection procedures if this equipment is available on the farm. Commercial application is possible but availability once again of individuals certified for the commercial application of fumigants limits the use of this technique in Maryland.

  Currently, Vapam is only available in 55 gallon drum containers. This packaging situation may limit the use of the product in Maryland tobacco production areas.

- POAST (*Sethoxydim*) - Poast is labeled for post-emergence control of grasses in tobacco plant beds. It is formulated as a 1.5 pound active ingredient per gallon mix. Use rate is 1 pint per acre and a crop oil concentrate (COC) should always be added to the mix at a rate of 2 pints per acre. For spot treating, a 1% spray solution could be used. Add 1 ¼ fluid ounces of Poast plus 1 ¼ fluid ounces of COC to 1 gallon of water. Note – the amount of COC in the mix is less in the spot treatment than the per acre treatment.

  Plants should be no smaller than a quarter in diameter prior to treatment. Remove cotton, remay, or vispore plant bed covers at least 24 hours and preferably 48 hours prior to treatment. This allows the plants to harden prior to chemical application. Allow the chemical mix to dry before putting covers back in place. Phytotoxicity can occur if plants are small and succulent.

**READ THE LABEL ON ALL CHEMICALS DISCUSSED IN THIS SECTION. FOLLOW THE MANUFACTURER'S DIRECTIONS CAREFULLY.**

<u>Weed Control – Non Fumigant</u>

The availability of chemicals for plant bed fumigation is becoming increasingly harder to find. With the pending loss of Methyl Bromide, packaging sizes hampering purchasing decisions of other products, and difficulty of locating and stocking in farm supply stores, growers will find the production of bare root transplants more difficult.

Alternative means of disinfestations -

A study was completed in 1996 in North Carolina regarding the inoculum eradication of *Rhizoctonia solani*. *R. solani* is one of the major organisms to cause damping-off and target spot in transplant production in greenhouses and outdoor beds. The organism is soil borne and one of the targeted pests to control in plant bed and float system culture. Of all the treatments studied for inoculum eradication, only Methyl Bromide and steam treatments (176 degrees F for 30 minutes to 2 hours) eradicated the inoculum. Dry heat treatments (158 to 176 degrees F for 2 hours) and sodium hypochlorite reduced the levels of inoculum in trays from 14 to 45 percent.

There is evidence that several pathogens other than *Rhizoctonia* and *Pythium* can cause other plant bed diseases (i.e. damping-off), which are *Fusarium*, *Phytophthora*, and *Sclerotinia*. High temperatures (shown in the following chart on page 19) created by steam or solarization may be of benefit to stop or slow down organisms' development.

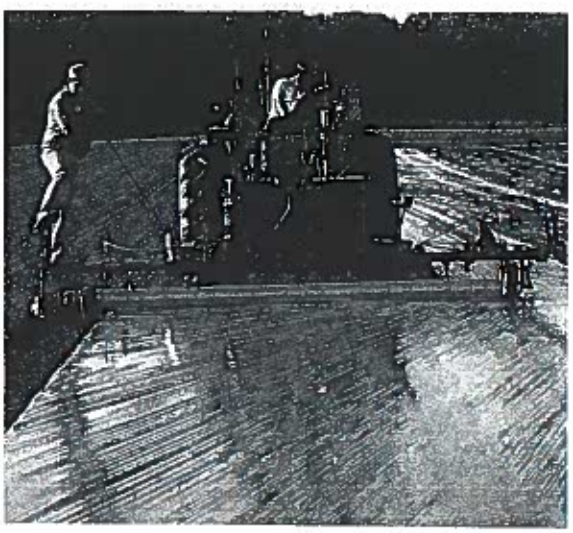
Use of existing weed control chemicals -

Considering the fact that steam generation is not an option for most, the only remaining option is to utilize clear plastic placed over the plant bed area in "early fall" to create a green-house effect. Utilizing the intensity of sunlight to elevate the air temperature under the plastic to high levels several days in a row may help in obtaining the solarization effect. The plant beds should be prepared as before, tilled, clod free, and level. The moisture level should be between 25 and 50 percent field capacity. Seal plastic edges down and leave in place for at least 7 days (and preferably through the winter months.)

After making plant beds, if grass escapes occur, apply POAST for post emergence grass weed control. If using POAST, wait until the young tobacco plants are the size of a quarter, remove plant bed covers at least 2 days prior to treatment, and apply the chemical over small grass escapes.

After transplant pulling season, do not allow bed sites to become overgrown with unused transplants or weeds. Always destroy plant bed sites after transplanting. Overgrown plants and weeds are a harbor for disease organisms, insects, and viruses to get established.

The availability of fumigants and the expense of commercial application will require alternative means of disease and weed control.



Reference Chart for Evaluation of Steam and Solarization Options 1/

| Site | Material | Formulation | -- Benefit to help control-- | | |
|---|---|---|---|---|---|
| | | | Bacteria | Fungi | Virus |
| Soils & Beds | Steam | Heat soil from 180 to 200 degrees F 30 minutes to a 6 inch depth | ☑ | ☑ | ? |
| Soils & Beds | Dry Heat | Heat soil to 180 degrees F for 30 minutes (small quantities) | ☑ | ☑ | |
| Soils & Beds | Solarization | 140 degrees F 4 to 8 hours per day for 7 days | ? | ☑ | |
| | | | | | |
| Tools, Equipment, Pots, Flats | 5.25% Clorox | Mix 6 gallon per 100 gallon water; Dip 10 seconds and drain | ☑ | ☑ | ☑ |
| Tools, Equipment, Pots, Flats | Steam | Heat objects 180 degrees F Cover or seal | ☑ | ☑ | |
| Tools, Equipment, Pots, Flats | Solarization | 140 degrees F 4 to 8 hours per day for 7 days | ? | ☑ | |

1/ North Carolina Extension Service

Use of float system culture for the production of tobacco transplants

Growers also have the option to abandon bare root transplant production and adopt transplant production utilizing float system culture. Section III of this Handbook covers this topic extensively. This production system is not without problems but when closely managed there are many advantages to be gained. With the loss of Methyl Bromide (used to fumigate polystyrene float trays after usage), complete tray washing with high-pressure washers or hot water, soap, and a brush, are mandatory production practices for sanitation. Rinse off excess potting soil and foreign debris after transplanting during lunchtime and at the end of the day's transplanting. Wash and clean up trays "as soon as possible". The longer cleaning is delayed, the harder it is to remove soil, algae, root matter, and other dried debris. If at all possible, do not allow the trays to come in contact with the ground (soil) when transplanting. This is another contact source to pick up organisms to contaminate trays.

Most polystyrene trays last at least four years. Growers should plan on replacing broken, worn out, or excessively dirty trays as often as necessary (or more often than they have become accustomed to).

## Seeding Tobacco Beds

Seeding can be done by hand or with mechanical seeders. The important thing is to get even distribution of the seed over the bed. Late February or early March is considered the best time to seed tobacco plant beds.

The seeding rate for raw tobacco seed is 1/4 to 1/3 ounce of clean seed with germination 80% or above per 100 square yard bed. The soil should be packed after seeding. This helps the seed make contact with moisture that aids in germination and emergence of the seedling.

## Covers for Tobacco Beds

There are four styles of tobacco plant bed covers in use today for the production of tobacco transplants. They are: synthetic fiber covers (i.e. nylon and reemay); plastic covers (solid and perforated); polyethylene porous formed film (i.e. VisPore); and, cottons.

- Synthetic fiber covers – These covers have been proven to be very satisfactory under Maryland conditions. They should be applied flat over a light coating of clean straw or other weed free material. Anchor firmly to the ground to prevent wind removal. In most seasons, plants grow faster under the synthetic fiber covers than under the older cotton covers, but not as fast as plastic. There are no heat build-up problems as with plastic covers. The synthetic fiber materials will "light age"; therefore, store in a dark place. However, they will not rot in contact with the ground like cotton covers.

- Plastic covers – These covers, both solid and perforated, are being used by growers. They will normally "push" plants faster than other types of covers. However, there is a danger of heat build-up, particularly with solid covers, that can kill or injure young plants. Solid plastic covers are best used to get early germination and the plants to about the 4-leaf stage – then remove and replace with another type of cover. Some growers are satisfactorily growing plants entirely under perforated plastic covers. Perforations should be at least ¼ inch holes on 2-inch centers. This will aid in preventing heat build-up and will allow water to get through. However, under Maryland conditions, some growers report heat damage with perforated plastic covers.

  Apply plastic covers flat over a light coating of clean straw or other weed free material following a rain or irrigation. Seal edges tightly with soil. Do not allow the surface of the soil to dry out. Remove or roll back solid plastic covers when the temperature gets 80 degrees F. or above. Perforated plastic covers can stand somewhat higher outside temperatures.

- Polyethylene porous formed film - This product is the latest and most recent to appear

on the market for transplant production. It is made of clear polyethylene that is porous. It has very fine funnel shaped holes and should be applied with the top (wide end) of the funnel up to allow water to go through and not let too much heat escape. It also has some stretch to it and will not puncture as easily as some other covers. The product claims to allow more light transmission over conventional covers and the soil retains more moisture due to less pore space in the formed film. This cover can also be used for float system transplant production when used to cover frame tops on outdoor float beds (see section III). When applied to float frame tops, the wide end of the funnel should be placed down so as to allow heat build-up to escape while minimizing water infiltration which damages float trays.

- Cotton – This material was the material of choice for many years. Its popularity has lessened because other products were less expensive and lasted longer. When taken care of properly and applied over top of clean straw, several years' usage can be obtained with these covers.

### Watering Tobacco Beds

Herein lies the success or failure of many tobacco beds. When the ground temperature reaches 50 degrees F. and germination starts, these minute seedlings are in a critical stage of growth. The moisture in the surface fraction of an inch is all-important at this time. A season with adequate rainfall is very rare; therefore, watering should be started early. Watering schedules and spray schedules should be worked together, spraying following watering. Excess moisture can enhance damping-off diseases.

Sprinkler type irrigations systems are the best way to apply water to tobacco beds. These systems can be adjusted to apply water at a rate the soil can take up. They are simple, relatively inexpensive, and require practically no labor once they are set up.

During the early stages of plant growth, a light sprinkling daily of 100 to 150 gallons of water per 100 square yards should be sufficient. During later stages of plant growth, 1/2 inch or 285 gallons three times a week is necessary for each tobacco bed to be productive.

### Tobacco Bed Disease and Insect Control

Table 4 and Table 5, page 22, show pesticides approved for tobacco bed disease and insect control. The use of these materials in Maryland is approved at the time of this publication. All tobacco bed sprays should be applied with ample pressure to get coverage on both sides of the leaves. This will require 3 to 10 gallons of prepared mix per 100 square yard bed depending on the size of plants. Begin sprays when leaves are the size of a dime and repeat twice weekly and after rainfall. Continue until beds are destroyed.

Be sure your sprayer is clean. Tobacco plants are sensitive to many pesticide compounds and residues left in spray tanks from previous usage could cause damage.

Handle all chemicals with care. Read the label and follow directions.

Table 4
Tobacco Bed Disease Control, Maryland Tobacco, 2004.

| Product | Target | Rate | Method | REI(*) (Hours) |
|---|---|---|---|---|
| Bordeaux | Wildfire<br>Angular Leaf Spot | 1 ¾ cups of spray lime and 1 cup of bluestone per 5 gallons water | Post | |
| Carbamate WDG | Blue Mold<br>Anthracnose | 1 tablespoon per gallon | Post | 24 |
| Dithane DF | Blue Mold<br>Anthracnose<br>Target Spot | 1 teaspoon per gallon | Post | 24 |
| Agri-mycin 17% | Wildfire<br>Angular Leaf Spot<br>Erwinia spp. | 100 to 200 ppm per bed (2 to 4 tablespoons per 5 gallons water) | Post | 12 |

(*) Restricted Entry Interval (Worker Protection Standard; Minimum interval in hours from application to worker re-entry into field).

Table 5
Tobacco Bed Insect Control, Maryland Tobacco, 2004.

| Product | Target | Rate | Method | REI(*) (Hours) |
|---|---|---|---|---|
| Syston 15G | Aphids<br>Flea Beetles | 9 ounces per 100 square yard bed | Post | 48 |
| pel DF | Lepidoptera spp. (worms) | 1 teaspoon per gallon | Post | 4 |
| hene 97P | Aphids<br>Flea Beetles<br>Vegetable Weevils | ¾ tablespoon per gallon (plant beds); ¾ tablespoon per 3 gallons (float beds) | Post | 24 |
| odan 3EC | Aphids | 1.25 teaspoon per gallon | Post | 24 |

Restricted Entry Interval (Worker Protection Standard; Minimum interval in hours from application to worker re-entry into field).

**tment of Plant Beds at Pulling Time**

The seedbed should be watered thoroughly before drawing if the soil is dry. This will nt breaking the roots of the tobacco plant when pulling. Plants should always be drawn lly so as not to disturb the plants left in the bed. Draw plants of uniform size for

individual plantings as uniform plants grow and mature more evenly in the field. Water your beds after pulling. This will help the young plants that were loosened by the pulling operation; thus insuring more tobacco plants. If the plants are yellow from nitrogen deficiency or growing slowly, apply about 2 pounds nitrate of soda or equivalent before watering.

**Precaution** – Do not pull any diseased plants and use them for transplants in the field. Blue mold, black shank, wildfire, anthracnose and tobacco mosaic can very easily be carried to the field in diseased plants. When finished pulling plants for the season, destroy plant beds when transplanting is complete. Overgrown plant beds can harbor insects and diseases.

**Clipping and Undercutting of Plantbeds**

Extensive research has been conducted in the southern tobacco producing states on methods of transplant production that would increase uniformity and reduce labor. Clipping of plants is now considered a field plant bed production practice in the flue-cured growing region. Plants are clipped two or three times starting when the largest plants are four inches tall. Plants are clipped about ½ inch above the bud each time at four to five day intervals. Clipping using this procedure delays plants seven to 10 days; however, plants are more uniform, stocky, and easier to pull.

Modified high clearance hand lawn mowers and tractor mounted rotary mowers can be used for clipping. With smaller hand mowers, start in the center of the plantbed and throw the clippings out. Most tractor mounted rotary mowers throw the clippings off of the plantbed resulting in no problems.

After plants have been clipped 3 or more times, they become very uniform in size for either hand pulling or undercutting. Undercutting allows plants to be pulled much more quickly because there is little resistance to pull. The time required in pulling undercut plants is estimated to be one-half of the time involved in pulling non-undercut plants. Undercut plants also have a better root system. Plants are undercut at a depth of about two inches with a specially designed blade mounted on a tractor. The plantbed should have adequate, but not excessive moisture to undercut properly. Grass and undercutting blades do not get along; therefore, keep outside edges clean to allow the blade to penetrate the soil easily.

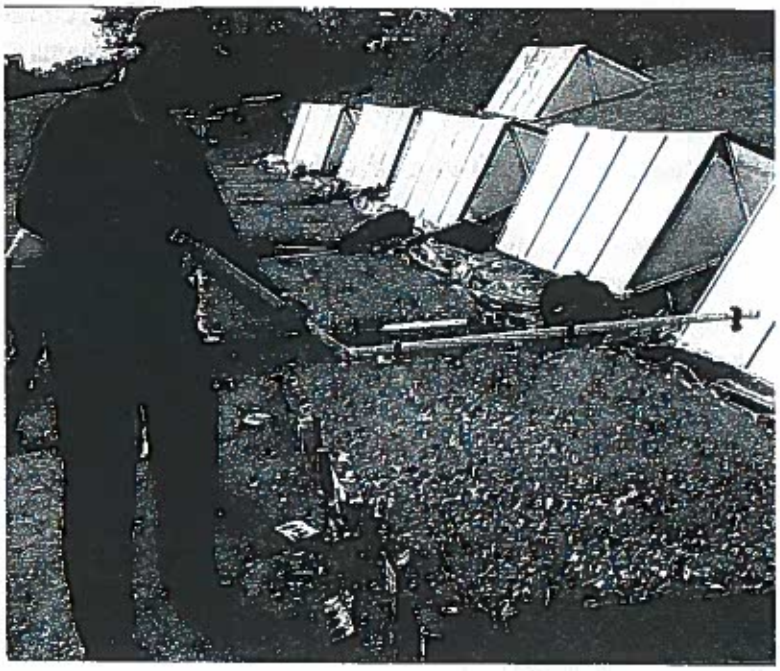
Recommendations for two systems of undercutting Maryland plants

1. Clip plants up to 6 times until all are relatively uniform. Undercut and check for uniformity. If about 65% appear to be of size to transplant, no selection is really needed and all plants can simply be loaded for transplanting and droppers do the culling. **This is a one-time operation.** Tests in Maryland have shown over 20,000 plants per 100 square yard bed are produced at the one pulling. Labor is reduced about 65%.

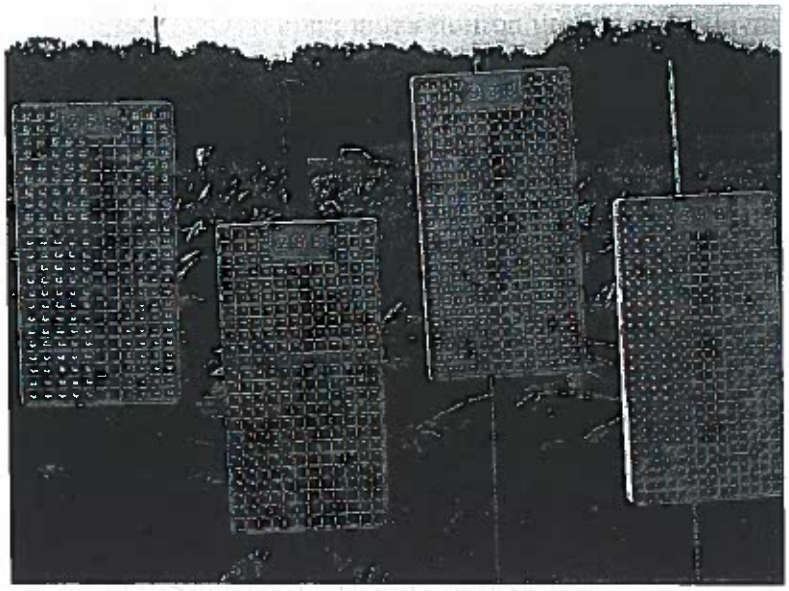
Note - This system can also be used as a clean up for clipped beds that have been

hand pulled before.

2. Clip plants until they are uniform - normally 3 or more times. Then undercut and selectively pull. Beds should be watered after pulling to get another pulling. Selectively pulling undercut plants reduces time by about 50%.



Spraying plant and float beds is extremely important for clean healthy plants.



Growers may want to consider float culture for transplant production as an alternative to bare root plant production.

Section III

# GREENHOUSE AND OUTDOOR FLOAT BED SYSTEMS FOR TRANSPLANT PRODUCTION

## Introduction

The use of greenhouses and outdoor float beds for tobacco transplant production has expanded very rapidly in flue-cured and burley producing areas. Greenhouses are now commonly seen on many tobacco farms and float systems account for approximately 80% of transplant production in both regions. The float system utilizes shallow plastic lined water bays that float polystyrene trays containing the seedlings. The polystyrene trays are 13.5 inches by 26.5 inches and range from 200 to 392 individual cells per tray. An area roughly the size of a 4-yard by 25-yard tobacco bed under the float system using 200 cell trays would produce over 60,000 usable plants (82% stand). With trays containing 288 cells the number of usable plants would increase to about 88,000. At 6000 plants per acre, this would be 14.7 acres of tobacco.

This is a very intensive plant production system compared to field plant beds and thus requires substantial management and investment. However, there are many advantages. There is no plant pulling labor involved and plants are adapted to newer labor saving transplanting systems. Transplants have an intact root system for excellent field survival and under greenhouse conditions you can schedule seeding to have transplants when you want them or hold them to space out planting.

Greenhouse float systems involve a greenhouse with automatic heating and ventilation, constructed bays for holding float water, polystyrene trays, potting soil mix to fill trays, pelletized tobacco seed, a tray seeding device, and a system for clipping the plants. In some tobacco producing areas, very small plants are available and are called "plugs". These can be manually transferred to the cells in the trays. This eliminates the need for pelletized seed and a seeding device and allow for outdoor growing of float trays under some conditions. However, plugs are an additional cost and require labor to plant in the cells. Studies show that the pelletized seed method is more efficient than the plug and transfer method.

Outdoor float systems have been tested with pelletized seed. Essentially these are miniature greenhouses with low arches to hold the plastic cover. Some form of uniform heat is necessary to get uniform germination and the ability to ventilate on hot days is essential. Costs could be reduced with this type of system, but management is still critical and a system of clipping must be devised.

Good water quality is necessary in float bed culture. Clean water from a well source should be used only. The presence of disease microorganisms in streams, rivers, or pond water creates too much of a risk for using this water as the water source.

## The System

The float bed system as an alternative to the production of tobacco transplants is utilized in two concepts: (1) outdoor float beds; and (2) greenhouse structures. In this section individuals can review basic production information relevant to both systems should they consider starting an outdoor float bed system or purchase a greenhouse structure for producing tobacco transplants. Planning and management requirements are far more extensive for greenhouse systems but most agronomic practices apply to each system.

Tobacco transplants are produced in floating polystyrene (styrofoam) trays consisting of individual cells with small holes in the bottom. The trays, filled with a moistened soil less media, are dibbled making a place for seed to fall and seeded with pelletized seed using a specially designed vacuum seeder. All fertilizer is supplied in the float bed water. As the media "wicks up" the water, the pelletized seed becomes wet and germinates under proper temperature conditions. Over the next 8 to 10 week period, the float bed system is managed so tobacco plants are produced for field transplanting when the grower is ready.

Tobacco float culture in a greenhouse.

Tobacco float culture in outdoor float beds, Upper Marlboro.

**Benefits and Disadvantages -**

Producing transplants in a float bed system has several advantages. Although initial per acre costs are higher, 2nd, 3rd, and 4th year costs are much less for outdoor float bed systems. Typical 1st year start up costs are approximately $170.00 per acre for 1 outdoor bed. After the first year costs, plants are produced for much less (approximately $45.00 per acre).

For general planning purposes, $6.00 per square foot is a good estimate to figure for pricing a greenhouse structure complete with heating, ventilation, and clipping systems. This could be more or less depending upon whether the grower does most of the installation or has to pay to have the system professionally installed. The payback for greenhouse systems, based upon $6.00 per square foot and 200 usable plants per tray is between two and three years.

Plant production labor is spread out over a less critical time period. Labor is needed to construct float beds (initially), to fill the beds with water, fill trays with media and seed, and move the trays to the beds. Float beds must be managed and clipped. However, when plants are mature, within minutes vehicles are loaded with trays and moved directly to the field to begin the transplanting operation.

Disadvantages are also apparent. As said earlier, initial start up costs are high. The availability of pesticides registered for this system is limited. Currently, only ORTHENE (*Acephate*) and DITHANE DF (Mancozeb) are registered for float bed systems. Farmers must adhere to strict sanitation measures around float beds and then clean trays after transplanting. The temperature under covers and in greenhouses should be monitored regularly. Water and fertility levels should be monitored as well.

**Construction**

Materials for construction of outdoor float beds consist of CCA treated lumber, 6 mil black plastic, a cover which may be either 4 mil clear solid plastic or VisPore, and a cover support system consisting of either CCA treated wood or PVC pipe. Option - A waterbed heater to heat the float water should be considered for March seeding.

Select an unobstructed level site located close to electricity and a water supply. Any minor deviation in levelness may impede the total volume of water the bed is capable of holding.

Waterbed dimensions vary and depend on the number of trays the farmer plans on floating. It is suggested for a grower's first year to keep float beds small. Beds can always be enlarged or altered later. Since float tray dimensions are 13.5 inches (width) by 26.5 inches (length), inside bed dimensions should allow for the placement of trays 5 trays wide (5 trays x 13.5 inches), but never greater than 6. The length of the float bed is then determined by the number of trays to be placed in the float bed. It is advisable to have 2 extra inches of free space for the movement of trays during management. Framing material should

consist of 2 inch x 4 or 6 inch CCA treated lumber. A cover support system with A-frame sloping sides made either of CCA treated wood or 3/4-inch PVC pipe must be erected. Since the outdoor float bed is a "mini-greenhouse" itself, a cover that may consist of clear solid plastic or VisPore needs to be placed over the bed and attached.

After leveling, remove all stumpage or other debris that may perforate the waterbed itself. Lay plastic tarp onto the ground next for final assurance. Install the waterbed heaters based upon 1 - 350 watt heater per 20 trays. Line the float bed with 1 layer of 6 mil black plastic. Always add about 1/4 inch of water before securing the 6 mil black plastic to the top of the frame. This will allow any wrinkles to be removed prior to securing the plastic to the frame.

Many of the same considerations apply to the location of a greenhouse. The site must be level and located near electricity and water. Popular greenhouse sizes are 30 feet by 72 feet and 30 feet by 100 feet. Heating systems may consist of fuel oil or propane. Ventilation systems involve fans with or without ventilation tubing to move air when necessary. When constructing the float beds, leave a 24-inch walk way down the center of the greenhouse. Locate the outside edge of the float bed in such a location that the clipping mower reaches all of the plants along the outside edge. Locate temperature and ventilation controls in the center of the greenhouse with a shade protector to minimize the influence of direct sunlight. If the grower reaches the decision that a greenhouse is the desired structure, the clipping system that can be purchased for installation inside the greenhouse (which operates on round tubing or rails) is highly recommended.

**Materials for seeding – The Process**

Polystyrene float trays are commercially available in the following cell numbers: 200, 242, 253, 288, 338, and 392. Popular in the Southern Maryland area are the 200, 253, and the 288 tray sizes. Research at the Upper Marlboro Facility and the Wye Research and Education Center, Queenstown, has been conducted utilizing all of the above mentioned tray sizes except for the 242 tray. A summary of tray performance based upon germination, tray yield, and plant size is found in Tables 6 and 7, page 29. Most individuals will be satisfied with a plant originating from the 253, 288, and 338 tray. The 200 tray produces a nice big plant but the cost per plant greatly increases. Few if any individuals will value the 392 float tray size.
More plants are actually produced in the 338 tray and adequate ventilation and spray coverage is always in question with the 392 tray. The 338 and 392 trays produce a smaller plant.

Table 6
Evaluation Parameters for Polystyrene Float Tray Performance, Greenhouse, WREC, Queenstown, MD, 2000

| Tray Size | Germination | Tray Yield | Plant Size (gm) |
|---|---|---|---|
| 200 | .88 | .79 | 7.91 |
| 253 | .88 | .76 | 7.25 |
| 288 | .88 | .74 | 6.51 |
| 338 | .88 | .74 | 5.53 |
| 392 | .88 | .71 | 5.95 |
| Average | .88 | .75 | 6.63 |

Table 7
Evaluation Parameters for Polystyrene Float Tray Performance, Outdoor Float Beds, CMREC-UMF, Upper Marlboro, MD, 2000

| Tray Size | Germination | Tray Yield | Plant Size (gm) |
|---|---|---|---|
| 200 | .75 | .70 | 9.24 |
| 253 | .70 | .65 | 8.72 |
| 288 | .71 | .65 | 7.15 |
| 338 | .72 | .66 | 6.28 |
| 392 | .74 | .66 | 5.72 |
| Average | .72 | .66 | 7.42 |

Extension and research workers who have been involved in the evaluation of float tray sizes report no differences in yield per acre when using plants originating from these different tray sizes. This has been the experience here in Maryland as well.

Trays are filled with an unfertilized soil media designed for tobacco transplant production. This media is moistened following label instructions by adding about 1 gallon of water per cubic foot of media. Trays are filled by hand carefully to be sure no air gaps exist in the cell columns. Water must be able to "wick" its way up through the media particles and contact (and wet) the seed. After filling trays with media, a dibble board is utilized to place a small indentation in the media to center the seed in the cell and improve moisture contact with that seed.

Seeding is done using a specially designed vacuum seeder with a seeding plate that fits the tray size. Seeders, plates, and dibble boards are commercially available from farm

supply stores, while some farmers have made their own at home. Presently, all Maryland tobacco cultivars are pelletized and available for grower use.

**Management – Key to success**

Prior to seeding trays, fill float beds with 4 inches of water and add 20-10-20 water-soluble fertilizer at the rate of 6.7 ounces per 100 gallons of water. This amount of fertilizer will give you a 100 parts per million (ppm) nitrogen concentration in the water and should be enough nutrient solution to last halfway through the growing cycle. Water quantity is determined by multiplying the float bed's length x width x depth (which determines the total cubic feet of available water) and then multiplying this value by 7.48 (gallons per cubic foot) to determine the total water volume in each bed. Later in the growing cycle, it will be necessary to add additional 100 to 150 ppm nitrogen. More clippings conducted (discussed later) will result in the higher amounts of nutrients applied This is accomplished by adding 3.3 ounces of 20-10-20 fertilizer to the float system for each 50 ppm nitrogen desired. It is usually applied at a time when it is necessary to add additional water (due to plant uptake and evaporation losses) and may even follow clipping time.

Instruments to measure dissolved solids (fertilizers) are available. A calibration chart is available which converts the numerical reading on the LCD to ppm of nitrogen in the nutrient solution. Early in the growing season when nutrient uptake by small plants is minimal, it is important to keep the water level at the calculated level to hold the 100 ppm concentration. When evaporation (and transpiration) losses occur and water levels decrease, the ppm concentration of fertilizers (and fertilizer salts) increases. Growers have lost plants this way when known ppm concentrations have exceeded 500+ ppm nitrogen.

Recommendations involving the timing of the initial application of soluble fertilizer have changed from when this practice began. Most Extension agronomists are now recommending delaying the initial application of fertilizer until after seeding and floating the trays.

In a greenhouse study located at the Southern Piedmont Agricultural Research and Extension Center, researchers found as much as a 15% average seeding mortality compared to 6% where fertilizer was added three days after seeding. 150 ppm N was used. Delaying the initial fertilizer application resulted in 5 to 15% more usable transplants.

At the Upper Marlboro Facility of the Central Maryland Research and Education Center, a small experiment was started in the growth chamber with a float seeding involving Maryland 609. In a replicated test, MD 609 was seeded in six float trays (392 float tray size) and floated in solutions that received no fertilizer or 100 ppm N. The daytime temperature was held to 72 degrees F and nighttime temperature was held to 65 degrees F. Seed germination for the no fertilizer treatment was 76.9% while germination for the fertilizer treatment was 71.9%.

The obvious solution to this apparent salt injury is to delay the initial application of water-soluble fertilizer for several days after floating the seeded trays. The Virginia study added fertilizer three days after seeding and floating the trays. Most of this seed is primed seed that usually emerges in less than seven days. When using non-primed seed like Maryland varieties, this delay could be much longer (i.e. 7 to 14 days after seeding).

Adding fertilizer after seeding and floating the trays is not without complications. Outdoor float beds usually contain no more than 25 or 30 trays. Bucket mixing the fertilizer and dumping some of the contents into each corner of the bed is easy to do. To prevent an immediate salt concentration buildup in the corners you must turn on the water hose and circulate the float bed water. This helps with mixing while adding water at the same time.

Greenhouse float beds present a different problem. Beds are much larger and contain more trays. You may not have convenient access to each corner of the bed area. Since the water volume is much greater, mixing becomes very difficult. The addition of water soluble fertilizer would best be accomplished by a circulating system. This would help minimize the immediate build up of salts that would happen if the nutrient enriched solution was just "dumped" into the float beds and circulation generated by adding water from a single water hose.

A water circulator system made of ½ inch and ¾ inch PVC pipe can be constructed to create a water circulation pattern in the bed. The piping system is laid on the plastic liner covering the floor, and a sump pump moves the water. The greenhouse manufacturer may suggest a specific pattern for the pipe in the circulation system. Fertilizer can be injected into the water and distributed by this water circulator system.

It would also help when adding the initial water into the float bed to minimize the amount you put in to a depth no greater than 2 inches. By circulating the water and adding the nitrogen solution you then elevate your water depth to the calculated and desirable amount.

To improve germination and tray yield performance of Maryland tobacco varieties, you may want to try something like this on a small scale first before enlarging it to cover a broader area.

If waterbed heaters are used, set thermostats so water temperatures are elevated to 70 - 80 degrees F. after putting the seeded trays into the float bed. The insulation properties of polystyrene will help to hold the heat in the water so the temperature elevates quickly. When loading the seeded trays, it may be a good idea to invert an empty float tray in the center of the bed over each waterbed heater. This allows heat to rise from the water to the air level of the germinating seed.

Set the thermostat to 72 degrees F. inside the greenhouse. Hold this temperature throughout the germination period (approximately 21 days). After germination is complete, nighttime temperature settings can be lowered to 62 to 65 degrees F. Do not allow daytime

temperatures to exceed 95 degrees F. when the plants are small. Lower sidewalls of the greenhouse and operate the ventilation systems to exhaust high temperature daytime heat and moist air.

Throughout the estimated 10-week growing period for outdoor float beds, or 8-week period for greenhouses, monitor very closely the presence of feeding insects or developing diseases. Currently, only 2 pesticides are registered to be used in float systems; ORTHENE and DITHANE DF.

Refer to Table 4 and 5, page 22, for application rates of these two compounds. Apply compounds uniformly over plants to control vegetable weevils and aphids. Sprays also serve as a preventative spray program for diseases such as blue mold, anthracnose, and target spot. Apply weekly sprays and always after clipping. Start when the plants reach the size of a dime. DITHANE DF received a Special Local Needs Registration for Maryland tobacco growers in 1995 due to the increased disease pressure being witnessed in tobacco growing regions of the United States from blue mold caused by a strain of *Peronospora tabacina* that has become "insensitive" to RIDOMIL (*mefenoxam*). The potential for phytotoxicity (plant injury) exists when this product is used on tobacco seedlings, and in particular, greatest potential exists in greenhouse float systems.

Never apply RIDOMIL in float systems. Do not use RIDOMIL for disease control in float bed production facilities, hydroponic production, or greenhouse facilities. Do not dip plants in solutions containing RIDOMIL or crop injury may occur. Off label uses of this compound promotes further development of insensitive strains.

Growers producing float plants will encounter **"spiral root"**. After germination, some plants will develop their white roots that stay on top of the soil media and fail to penetrate the media. Plants developing from this condition will be delayed in growth and never reach a usable size. Most researchers believe the cause of spiral root is two fold. First, packing the soil when filling the trays creates a bulk density in which the root cannot penetrate. Second, pore space (preferably for air) becomes filled with water and the soil becomes supersaturated and water logged. In this organic wet material the roots cannot grow in an oxygen deficit situation. When filling trays be sure the soil media is the correct moisture consistency. Avoid packing the trays when filling. Handle with care. Do not apply overhead watering.

Throughout the growing cycle, clipping of plants is necessary. The purpose of clipping is to increase the uniformity in plants and increase stem diameters. As plants grow out, they should appear to be toughened in appearance, and slightly yellow (nitrogen deficient). For a small-scale operation, trays can be removed from the beds and clipped with a high clearance mower. Begin clipping when plants reach 3 inches in height and clip no closer than ½ inch above the buds. Clip again when plants are 4 inches, 5 inches, 6 inches, and again at the 7 inch height. Plants utilized in the University of Maryland research program are considered ready for field transplanting when the last clipping results in a plant 6 ½ inches tall.

## Sanitation

Since few pesticides are registered for float bed production systems, the primary means of disease control is strict adherence to sanitation principles. Growers should incorporate sanitation practices during the following: (1) clipping; (2) post-plant period; and, (3) tray storage. After each clipping, rinse all mower parts that come into contact with leaf tissue with a 10% chlorine bleach solution (1 gallon of household bleach to 9 gallons of water). After planting, remove soil and media from trays. As soon as possible, wash out and clean each tray with a brush and soapy water to remove foreign debris. Prior to tray storage, wrap trays in plastic and fumigate using METHYL BROMIDE at the rate of 3 pounds per 1000 cubic feet.

Table 8 and Table 9, page 34, show the costs of production for one outdoor float bed using 253, 288, and 338 polystyrene float trays. Figure 1, page 35, shows a series of drawings that can be used for the construction of an outdoor float bed that holds 25 polystyrene float trays. Six of these float beds are available for grower inspection at the Central Maryland Research and Education Center, Upper Marlboro. This set of drawings is also available at the Upper Marlboro Facility in large print.

Transplants from a 200-cell polystyrene float tray.

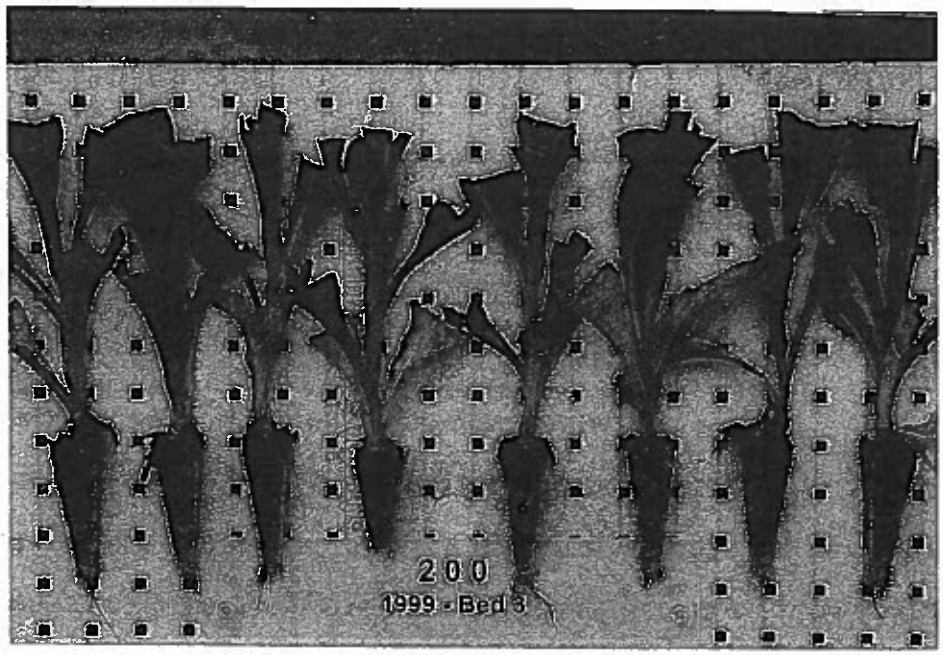
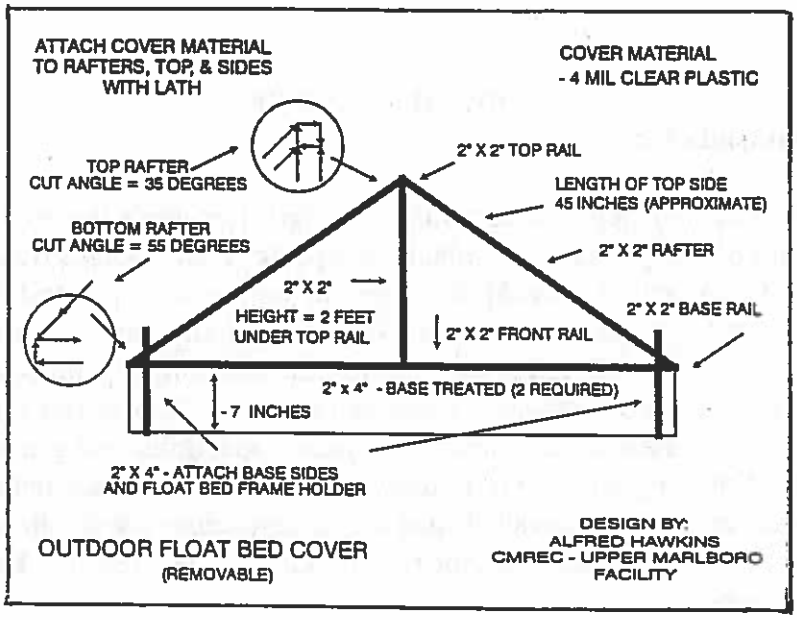


Table 8: Cost of Production for One Outdoor Float Bed Using 253 Polystyrene Float Trays for Maryland Tobacco Production, 4 Year Period.

| Materials | Number | Unit | Price | 1st Year | 2nd Year | 3rd Year | 4th Year |
|---|---|---|---|---|---|---|---|
| 2 inch x 4 inch x 12 ft. CCA Treated | 10 | each | 4.99 | 49.90 | | | |
| 2 inch x 4 inch x 8 ft. CCA Treated | 1 | each | 2.99 | 2.99 | | | |
| 6 Mil Black Plastic (7.5 ft. x 13 ft.) (Roll is 16 ft. x 100 ft.) | 97.5 | sq. ft. | 0.03 | 2.44 | 2.44 | 2.44 | 2.44 |
| 4 Mil Clear Plastic (10 ft. x 12 ft.) (Roll is 12 ft. x 100 ft.) | 120 | sq. ft. | 0.02 | 2.40 | 2.40 | 2.40 | 2.40 |
| Trays - 253 Cell Size | 25 | each | 2.29 | 57.25 | | | 14.31 |
| Tobacco Greenhouse Mix | 2 | 2.8 cu.ft. | 9.39 | 18.78 | 18.78 | 18.78 | 18.78 |
| Fertilizer (20-10-20) | 1.67 | lb. | 1.00 | 1.67 | 1.67 | 1.67 | 1.67 |
| Heat (Water Bed Heater) | 2 | each | 27.70 | 55.40 | | | 27.70 |
| Insulation Board (4x8x1 inch) | 66 | sq. ft. | 0.41 | 27.06 | | | |
| Seeding | | | | | | | |
| COST PER BED | | | | $217.89 | $25.29 | $25.29 | $67.30 |
| COST PER PLANT | | | | $0.05 | $0.01 | $0.01 | $0.02 |
| COST PER SQUARE FOOT | | | | $3.32 | $0.39 | $0.39 | $1.03 |
| COST PER ACRE (6223 Plants/Acre) | | | | $306.25 | $35.54 | $35.54 | $94.59 |

Table 9: Cost of Production for One Outdoor Float Bed Using 288 and 338 Polystyrene Float Trays for Maryland Tobacco Production, 4 Year Period.

| | < - - - - - 288 Cell Size - - - - > | | | | < - - - - - 338 Cell Size - - - - > | | | |
|---|---|---|---|---|---|---|---|---|
| | 1st Year | 2nd Year | 3rd Year | 4th Year | 1st Year | 2nd Year | 3rd Year | 4th Year |
| COST PER BED | $222.89 | $25.29 | $25.29 | $68.55 | $217.89 | $25.29 | $25.29 | $67.30 |
| COST PER PLANT | $0.04 | $0.01 | $0.01 | $0.01 | $0.04 | $0.01 | $0.01 | $0.01 |
| COST PER SQUARE FOOT | $3.40 | $0.39 | $0.39 | $1.04 | $3.32 | $0.39 | $0.39 | $1.03 |
| COST PER ACRE (6223 Plants/Acre) | $275.20 | $31.22 | $31.22 | $84.64 | $229.23 | $26.60 | $26.60 | $70.80 |


ATTACH COVER MATERIAL TO RAFTERS, TOP, & SIDES WITH LATH
COVER MATERIAL - 4 MIL CLEAR PLASTIC
TOP RAFTER CUT ANGLE = 35 DEGREES
2" X 2" TOP RAIL
LENGTH OF TOP SIDE 45 INCHES (APPROXIMATE)
BOTTOM RAFTER CUT ANGLE = 55 DEGREES
2" X 2" RAFTER
2" X 2"
HEIGHT = 2 FEET UNDER TOP RAIL
2" X 2" FRONT RAIL
2" X 2" BASE RAIL
2" x 4" - BASE TREATED (2 REQUIRED)
- 7 INCHES
2" X 4" - ATTACH BASE SIDES AND FLOAT BED FRAME HOLDER
OUTDOOR FLOAT BED COVER
(REMOVABLE)
DESIGN BY:
ALFRED HAWKINS
CMREC - UPPER MARLBORO FACILITY

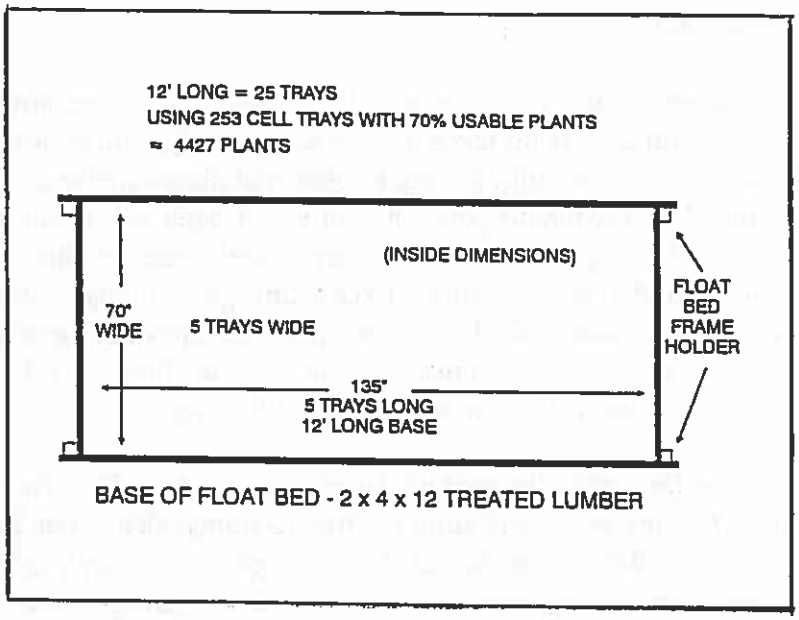
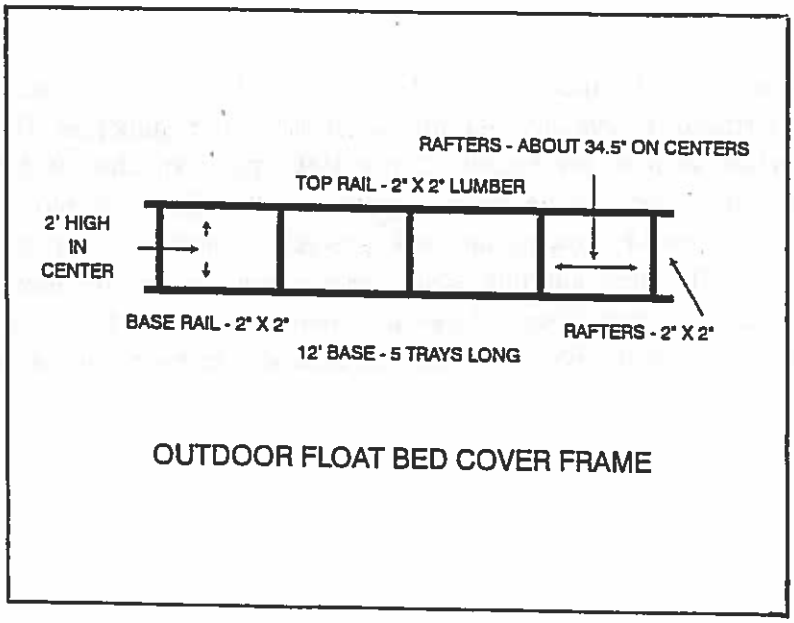

12' LONG = 25 TRAYS
USING 253 CELL TRAYS WITH 70% USABLE PLANTS
≈ 4427 PLANTS
(INSIDE DIMENSIONS)
70" WIDE
5 TRAYS WIDE
FLOAT BED FRAME HOLDER
135"
5 TRAYS LONG
12' LONG BASE
BASE OF FLOAT BED - 2 x 4 x 12 TREATED LUMBER

Figure 1


RAFTERS - ABOUT 34.5" ON CENTERS
TOP RAIL - 2" X 2" LUMBER
2' HIGH IN CENTER
BASE RAIL - 2" X 2"
RAFTERS - 2" X 2"
12' BASE - 5 TRAYS LONG
OUTDOOR FLOAT BED COVER FRAME

## Section IV

## FIELD CULTURE

### Fertilizer Recommendation

Soil Test - The first step in determining your fertilizer needs is a soil test. This will give you a measure of the quantity of available phosphate ($P_2O_5$), potash ($K_2O$), Magnesium (MgO), Calcium (CaO), and Organic Matter (OM) in your soil. A soil test further indicates the relative acidity (pH) of your soil that is important in determining your need for lime. Today, many private sector soil testing laboratories are providing high quality soil testing services for the agricultural community. These private sector laboratories (and some remaining public sector laboratories) have excellent analytical capabilities and generate reliable analytical results. Contact your County Extension Office for the names and locations of these soil testing laboratories. Your individual field recommendations for fertilizer and lime can still be made by your Extension Agent/Educator based on the soil test results. Fees will be charged for laboratory services.

### Plant Foods For Tobacco

Nitrogen - Nitrogen is one of the most critical plant foods in the production of Maryland tobacco. The tobacco plant takes up nitrogen from the soil as it needs it. Ideally we would like to have enough nitrogen to grow the plant rapidly to full size and have the supply diminish as the plant ripens. Too little nitrogen will result in small plants, early firing and low yield and quality. Excess nitrogen will cause the plants to grow too big and become difficult to harvest and cure. Excess nitrogen will also adversely affect the chemical content of the cured leaf. Present research indicates that between 60 and 90 pounds of nitrogen is necessary to produce a good crop of Maryland tobacco. Your individual field recommendations will normally fall in this range.

Nitrogen can be lost easily by leaching from many sandy soils. Therefore, side dressing a portion of the nitrogen application is often recommended. Side dressings should be applied between day 14 and day 21 after transplanting. Applying the nitrogen at this time will make it readily available just as the uptake of nitrogen begins to rapidly increase.

Research work has been conducted at the Central Maryland Research and Education Center, Upper Marlboro, to evaluate the utilization of the Pre-Sidedress Nitrogen Test (PSNT) for Maryland tobacco production. Since 1996, plot work has been conducted to evaluate residual mineralized nitrate nitrogen pools resulting from the plow down of hairy vetch and crimson clover. Following the same procedures used for corn production, there is evidence that the PSNT test could be used to recommend, or not recommend, additional nitrogen after the legume plow down. More plot years of data need to be accumulated before we know for sure if the PSNT test can be used as a nitrogen side dressing predictor.

Phosphate - Phosphate is necessary for the normal growth and maturity of the tobacco plant. Your recommended phosphate application when added to the available phosphate in your soil (expressed as FIV or fertility index value) should keep the available phosphate in the optimum (high) range. Most soil samples from tobacco fields test optimum (high) or excessive (very high) for phosphate. Thus, the recommended phosphate application will normally be a low rate or even 0. Leaching is usually not a problem with phosphate. There is some scientific data that shows under certain conditions dissolved phosphate can leach. In cases of continued heavy fertilization, a build-up of this plant food will occur. Excess phosphate can be lost on soil particles and organic matter in run-off water producing environmental problems. Excessive use of phosphate on Maryland tobacco is both costly and environmentally unsound. Phosphate fertilizer recommendations range from 40 pounds per acre (optimum FIV) to 120 pounds per acre (low FIV).

Potash - Tobacco is considered a heavy feeder of potash. It is particularly important in Maryland tobacco because it aids free burning of the cured leaf. Plants lacking adequate potash will have small leaves with a ragged appearance and of poor quality. Potash is not considered readily leachable from the soil. However, research indicates that each soil has a certain capacity to hold potash. The recommended potash application when added to the available potash in your soil should keep the available potash, once again, in the optimum (high) range. Potash fertilizer recommendations range from 120 pounds per acre (optimum FIV) to 200 pounds per acre (low FIV).

**Other Plant Foods and Minor Elements**

We do not have much research concerning the need for other plant foods and minor elements with Maryland tobacco. There have been field cases of magnesium deficiency in the past, but these were corrected with the use of a high magnesium lime. There have also been a few suspected cases of manganese deficiency where pH levels were very high and manganese toxicity where pH levels were very low. We do have an abnormal bud development condition in Maryland tobacco that we refer to as calcium deficiency, but it is more complex than that and cannot be corrected with the simple addition of lime. Research from Virginia with flue-cured tobacco has shown no significant response from soil applications of copper, zinc, and boron.

**Tobacco Fertilizer Information**

The analysis of a fertilizer, example 8-8-24, indicates the content of the plant foods in percent. An 8-8-24 fertilizer contains 8% nitrogen (N), 8% phosphate ($P_2O_5$) and 24% potash ($K_2O$).

Tobacco grade fertilizers are different from other fertilizers in that they are low in chlorine. The source of potash in most fertilizers is muriate of potash (KCl). This cannot be used for tobacco because of the chlorine (Cl). Therefore, tobacco grade fertilizers have to use other sources of potash such as sulphate of potash or nitrate of potash.

A high level of chlorine in the fertilizer can ruin the quality of cured Maryland tobacco. The tobacco has a grayish color with white stems and will stay in "high order" most of the time. Use only tobacco grade fertilizers on your crop.

It is costly to apply more nitrogen, phosphate and potash than recommended. About 75% of the plant food recommendations for tobacco based on soil tests call for 40 pounds per acre of phosphate. This would be supplied with 500 pounds per acre of 8-8-24. The additional nitrogen and potash needed can be supplied from straight nitrogen sources such as nitrate of soda (16.5-0-0) or ammonium nitrate (33.5-0-0) or combinations with potash such as nitrate of soda potash (15-0-14).

**Methods of Fertilizer Application**

Plow-Down - Spring plow-down of plant foods for tobacco has proven to be a satisfactory method of application on soils that are not excessively prone to leaching. Normally plow-down applications should be limited to about ½ to 2/3 of the total application. Research results indicated that when the total application was plowed down and the season was wet, yield was reduced.

Both straight nitrogen materials and mixed fertilizers can be plowed down. Research has shown that you get a definite benefit from plowing down about 30 pounds of nitrogen with a cover crop prior to planting tobacco. If your soil is low in phosphate, plow down applications of this plant food are also desirable.

Broadcast - Broadcasting of fertilizer is normally done just prior to transplanting. The fertilizer should be incorporated into the soil with a good deep disking. Broadcasting of fertilizer is fast and can be done with farm or custom spreaders.

Band - Transplanters are available with very satisfactory fertilizer banding attachments. The bands of fertilizer should be placed about 4 inches to the sides of the plant and 3 to 4 inches deep. Banding of fertilizer has generally been superior to broadcasting in most tests. The nutrients in the concentrated bands do not tend to leach as quickly as broadcast applications.

Sidedressing - Sidedressing applications are normally applied with either the first or second cultivation. It is a very good practice where soils tend to leach. In areas of light sandy soils, growers regularly sidedress once or twice to supply needed nitrogen. Sidedressing is also the only way to replace nitrogen lost from leaching. Many times growers who applied their total fertilizer application broadcast benefit greatly from sidedressing additional nitrogen after leaching rains.

Although nitrogen is the primary plant food of concern in sidedressing, additional potash is often applied as a sidedressing to soils needing this plant food.

General Conclusions:

- With the high rates of fertilizer now used on Maryland tobacco, the differences from the various methods of application tend to be small.
- Band applications and sidedressings are superior methods of application if your soil tends to leach.
- Broadcast applications of fertilizer for tobacco is the most commonly used method, but it can give the poorest results of the methods tested in both wet and dry seasons.

## LIME FOR TOBACCO

Tobacco responds to the addition of lime like other crops if the soil pH is low. Research work at the Central Maryland Research and Education Center, Upper Marlboro Facility, showed that tobacco grown on a soil with pH 5.4 produced up to $550 more per acre than tobacco grown on a soil with pH 4.5. However, there was little or no response in liming to pH 6.0 or above.

### Recommendations

Present recommendations for Maryland tobacco call for liming to a pH of 5.6 for good crop production. There are two reasons for not liming to a higher pH.

- Tobacco does not need a high pH like some other crops to produce satisfactorily.
- There are potential dangers from disease if the soil is limed above pH 5.6 for tobacco. Both black root rot (*Thielaviopsis basicola)* and black shank (*Phytophthora parasitica var.* nicotianae) are more active at higher pH levels.

There are questions from tobacco growers about what type of liming material is best for tobacco. The two major factors to be considered in buying lime for tobacco are: (1) does your soil need magnesium; and, (2) what is the cost per pound of oxide?

If your soil test indicates that you need magnesium, use a high magnesium liming material - one that contains 10% or more magnesium oxide (MgO). Some soil tests from the tobacco producing area show low and very low levels of magnesium. The use of a high magnesium liming material is a very easy and inexpensive method of correcting this deficiency. If your soil test indicates your soil already contains a high or very high level of magnesium, then you should apply the liming material that is least expensive and finely ground (100 percent passes through a 20 mesh sieve and 50 percent passes through a 100 mesh sieve).

### How to Figure Cost on Oxide Basis

State law requires that liming materials state the total content or equivalent of calcium oxide (CaO) and magnesium oxide (MgO) on the bag or delivery invoice in the case of bulk lime. Much of the bulk-spread lime has some moisture in it, referred to as "wet lime", to make

it environmentally easier to handle. Oxides should be reported on the total lime product taking moisture content into account. Figure your cost per pound of oxides to determine which is the best buy. A simple formula to determine the cost is:

$$\frac{\text{Price per ton}}{2000 \times \%\text{ total oxide}} = \text{cost per pound of oxide}$$

**Example** - A ground limestone costs $30.00 per ton spread and contains 45% CaO and 5% MgO (50% total oxide).

Cost per pound of oxide =

$$\frac{\$30.00}{2000 \times .50} = \frac{\$30.00}{1000} = 3.0 \text{ cents}$$

**Liming Materials Available in Southern Maryland**

1) Crushed or ground agricultural limestone - When this material is finely ground it is an excellent liming material. For good results, 98-100% should pass through a 20-mesh screen and 50% or more passes through a 100-mesh screen. This information is required to be on the bag or delivery invoice. Ground limestone that does not meet these screening specifications will be very slowly reactive in the soil. A typical bag found at a dealer in Southern Maryland showed 100% passing through a 20-mesh screen and 85% passing through a 100-mesh screen. This would be a very satisfactory grind. Total oxides normally run between 37% and 56% for ground limestone.

2) Hydrated lime - is produced by adding water to burned lime. The total oxides usually range from 61 to 78% and will be shown on the bag or delivery invoice. The fineness of grind does not apply. Hydrated lime is also caustic and difficult to handle, but it is also an excellent liming material.

**Plant Spacing**

1. For Maryland conditions, **5000** plants per acre would seem to be about the minimum level and **6000** plants per acre about the maximum level.
2. Sandy, droughty or infertile soils cannot support as many plants as loamy more fertile soils.
3. Low plant populations on fertile soils can result in large heavy tobacco that is difficult to harvest and cure.
4. High levels of plant populations, over **6000** plants per acre, should be used only if you are after maximum gross return per acre or if tobacco plants at lower population levels are too large to handle easily.

5. Lower plant populations will give higher labor efficiency because you get more production per plant.

**Table 10**
**SPACING CHART - PLANTS PER ACRE**

| Distance Between Plants - Inches | 36 Inch Row Spacing | 38 Inch Row Spacing | 40 Inch Row Spacing | 42 Inch Row Spacing |
|---|---|---|---|---|
| 36 | **4840** | 4585 | 4356 | 4190 |
| 34 | **5125** | **4855** | 4612 | 4393 |
| 32 | **5445** | **5159** | **4901** | 4667 |
| 30 | **5808** | **5502** | **5227** | **4978** |
| 28 | **6223** | **5895** | **5601** | **5339** |
| 26 | 6702 | **6349** | **6031** | **5744** |
| 24 | 7260 | 6878 | **6534** | **6223** |
| 22 | 7920 | 7503 | 7128 | 6787 |
| 20 | 8712 | 8253 | 7841 | 7567 |
| 18 | 9680 | 9171 | 8712 | 8297 |

**Bold numbered areas are considered to be in the desired range.**

**Skip-row Planting**

Skip-row planting is a practice that enables growers to spray their tobacco crop at any stage of growth with a normal farm tractor and sprayer. Spray rows or skip-rows are left out every 4, 6, 8, or more rows depending on the type and width of spray equipment used. The spray row has to be wide enough to get your tractor and sprayer through full-grown tobacco. Special mounted skip-row tobacco sprayers are manufactured and sprayers with long one-sided booms and pull behind rigs are also being used. Drop nozzles can be installed on these sprayers for larger tobacco when directed and targeted sprays are necessary for insect and disease control.

**Transplanting**

The best time for transplanting usually occurs about May 15 to June 15. Plantings set too early often will not grow rapidly if cool temperatures prevail. Some herbicides will cause injury if tobacco roots set in herbicide zones and grow out slowly. Plants set too late may run

into unfavorable curing weather and even on occasion – frost (see section on weather information).

Pull only disease-free, uniform, stocky plants with a good root system. Irregularity in plants many times results in a non-uniform crop and poor growth. If using greenhouse or outdoor float bed plants, research at the Central Maryland Research and Education Center, Upper Marlboro, and the Wye Research and Education Center has shown outdoor plants can be ready for the field in 10 to 11 weeks (6.5 inches) and greenhouse plants ready in 8 weeks (6.5 inches).

**Cultivation**

The primary purpose of cultivation is to control grass and weed growth that competes with the tobacco for plant food and water. Early cultivation may be made closer and deeper to the plants than later cultivations, but even then care should be taken so as not to disturb or tear the roots. Later cultivations are made only as needed to destroy weeds and grass. These should be made shallow with sweep type hoes.

**Chemical Weed Control**

Chemical weed control is almost a standard practice for Maryland tobacco growers. There is now a much wider choice of chemicals labeled for use in Maryland than a few years ago. Each has certain advantages and disadvantages, but none are "cure-alls" for all weed problems. Read the label before using any chemical and follow the instructions carefully. Ridomil (if needed for black shank suppression) and some nematicides and insecticides can be tank mixed with most herbicides. If you have problem weeds or grasses in your fields, have the plants identified and check chemical label information for possible control. Check the labels for compatibility. Following are the herbicides labeled for use on Maryland tobacco at the time of this publication:

**COMMAND** (*Clomazone*) - COMMAND was granted a state label for use in fields for tobacco in Maryland in 1992. It is formulated two ways for use on Maryland tobacco: (1) COMMAND 4EC - a 4 pound active ingredient per gallon mix with a use rate is 1.5 to 2 pints per acre; and (2) COMMAND 3ME – a micro-encapsulated 3 pound active ingredient per gallon mix with a use rate of 2 to 2.6 pints per acre. COMMAND 3ME is registered for pre-emergence application. With COMMAND 4EC it is **important** that the product be incorporated immediately after application or off-target movement will occur. For thorough incorporation, disk in two directions to a depth of 3 to 4 inches. Off site movement of spray drift or vapors of any COMMAND formulation can cause foliar whitening or yellowing of some plants. **Do not** apply COMMAND within 1,000 feet of residences, towns, or commercial vegetables, fruit, greenhouse or nursery operations. It is recommended that adjacent properties be checked and if susceptible and desirable plant species are present, that spraying be avoided within 1,500 feet. A partial list of weeds controlled includes barnyardgrass, crabgrass, foxtail, goosegrass, panicum, seedling johnsongrass, velvetleaf, common

ragweed, galinsoga, jimsonweed, lambsquarter, purslane, and smartweed.

**DEVRINOL** (*Napropamide*) - DEVRINOL is sold as an emulsifiable liquid containing 2 pounds of active ingredient per gallon and as a 50% dry flowable powder. Use rate is 1 to 2 pounds of active ingredient per acre. For the coarse textured soils of Southern Maryland, 1 to 1-1/2 pounds of active ingredient (2 to 3 quarts of the 2E or 2 to 3 pounds of the 50 DF) is sufficient. DEVRINOL can be applied pre-emergence or incorporated shallow, 1 to 2 inches, the same day that it is applied to the soil. One of the problems with DEVRINOL is that it has a long residual life in the soil. Thus, in order to establish a fall cover crop, fields receiving DEVRINOL must be moldboard plowed before planting. A partial list of weeds controlled includes barnyardgrass, crabgrass, foxtail, goosegrass, fall panicum, lambsquarter, pigweed, purslane, and ragweed (suppression).

**POAST** (*Sethoxydim*) – POAST 1.5EC is an emulsifiable concentrate which contains 1.5 pounds of active ingredient per gallon. This product provides a new and different tool for grass weed control because it is applied post-emergence to the grass and crop. This product is labeled for plant bed use (see discussion on tobacco bed weed control on page 17) and field production. For grass weed escapes apply 1.5 pints of POAST 1.5EC plus 2 pints of crop oil concentrate per acre. Like most post-emergence materials the weed control performance is greatly improved by making the application to grasses before they get too tall. A partial list of weeds controlled include barnyardgrass, crabgrass, foxtail, goosegrass, seedling johnsongrass, panicum, annual ryegrass, volunteer small grain, bermudagrass, johnsongrass (suppression), quackgrass, and perennial ryegrass.

**PROWL** or **PENDIMAX 3.3** (*Pendimethalin*) – PROWL 3.3EC is similar to many of the other herbicides listed. It should be preplant incorporated by double disking in two different directions. PROWL should not be deeply incorporated. PROWL does an excellent job on many annual grassy weeds and is available in a 3.3 pound active ingredient per gallon mix. Use rate is 1.8 to 3 pints per acre. Research has shown that PROWL gives some excellent suppression of morningglory under Maryland conditions. A partial list of weeds controlled include barnyardgrass, crabgrass, foxtail, goosegrass, seedling johnsongrass, fall panicum, purslane, lambsquarter, pigweed, smartweed, and velvetleaf suppression.

**SPARTAN** (*Sulfentrazone*) – SPARTAN is the newest weed control material to emerge on the Maryland market. There is a dry flowable product formulated as SPARTAN 75DF and the liquid formulation SPARTAN 4F. Spartan 75DF has a use rate for Maryland soils between 5.3 and 6.7 ounces per acre. The use rate of SPARTAN 4F for most Maryland tobacco soils is 8 to 10 ounces per acre. This product became very popular because it controls morningglory as well as several other hard to control broadleaf weeds. Injury can occur with the use of this product. Do not apply to soils classified as sand with less than 1% organic matter. Avoid early season applications. Pre-plant applications, heavy rains, and/or cool temperatures soon after application and transplanting can and will result in injury. Under Maryland conditions, a pre-emergence application is recommended at the use rates of 5.3 ounces (75DF) or 8 ounces (4F) on tobacco planted mid-to-late season. A partial list of weeds controlled

include amaranth, crabgrass, daisy, dayflower, fall panicum, hairy galinsoga, jimsonweed, lambsquarter, morningglory, nightshade, pigweed, purslane, smartweed, velvetleaf, and yellow nutsedge.

**TILLAM** (*Pebulate*) – TILLAM is also labeled for preplant incorporation. It is available in a 6-pound active ingredient per gallon mix. Use rate is 2-2/3 quarts per acre. TILLAM should be incorporated immediately after spraying with a double disk operating in two different directions. TILLAM controls many annual grasses and broadleaf weeds and provides some suppression of yellow nutsedge. A partial list of weeds controlled includes barnyardgrass, bermudagrass, crabgrass, Florida pusley, foxtails, goosegrass, lambsquarter, pigweed, purslane suppression, and yellow nutsedge suppression.

Field of Maryland 201 with excellent weed control.

Section V

# IRRIGATION

Nearly all quality characteristics in Maryland tobacco are improved by supplemental irrigation. Both foreign and domestic cigarette manufacturers desire leaf with the light colors, fluffy body and open texture that can only be obtained when tobacco has been grown with an adequate supply of moisture. Uninterrupted growth is necessary if a thick, tight-grained leaf is to be avoided.

## Water Supply

Water supply is one of the major problems on many tobacco farms. Ponds can be very satisfactory, but many do not have the recharge capacity to be of much use in the case of prolonged dry periods. Streams also are often not reliable in dry periods. The most dependable source of water on many farms would be a well and this can be costly. Some farmers have a combination well and small pond. This seems to be a very satisfactory set-up. A relatively low capacity well is pumped into a holding pond for use in field irrigation. With this type of system, a well delivering 30 gallons per minute would provide 1-1/2 inches of water for an acre of tobacco every 24 hours.

Each individual farm is different. Ponds or streams may be reliable for some farms whereas a well may be the only answer for others. The Soil Conservation Service can help you with ponds and streams and the Department of Water Resources of the State of Maryland can supply some information on wells.

There have been some problems in Maryland from using water for irrigation that was high in salt content. These have occurred in pumping directly from tidal streams or from ponds located close to tidal marshes. If you have any questions about using such water to irrigate tobacco, have a water sample checked for salinity first. This service is available through the Maryland Tobacco Improvement Foundation by submitting a water sample to your local Maryland Cooperative Extension Office.

## Soil Considerations

Irrigation should be considered only if your soil is well drained, well aerated and in good physical condition to rapidly absorb the water applied. On deep soils of good tilth with no erosion problem, the probable maximum rates of application and the water holding capacity of the soil are listed in Table 11, page 46.

Table 11
Soil Considerations With Irrigation

| Soil Texture | Maximum Application Rate Inches Per Hour | Available Water - Inches Per Foot of Soil |
|---|---|---|
| Very Light | .8 to 1 | 1 |
| Light | .5 to 1 | 1.5 |
| Medium | .4 to .7 | 2 |
| Heavy | .3 to .5 | 2 |

**Other Factors Related to Soil**

- Rate of water application must be reduced for soils of poor tilth, steep slope, poor drainage or hardpan.
- The amount of water the soil will hold helps determine the frequency of application.
- Total water per application should not exceed the capacity of the soil to hold water. Excessive water facilitates leaching and erosion.
- Slope of the land affects power needed, rate of application and design of equipment.

**When To Irrigate**

There are three stages during the growth of tobacco when irrigation is most important. The first stage is at the time of transplanting if there isn't enough rainfall. At this stage ½ inch of water is usually enough (1 acre inch is 27,000 gallons). The second stage is from knee height until blooming time. This is the maximum growth period for the plant and ample water for normal growth is most important. During this time period tobacco should get about one inch of water per week. The third stage for irrigation is at ripening time when about 1 inch will give more uniform ripening.

**Management**

It is desirable to apply as much water as you safely can at one setting from a labor standpoint. However, excessive irrigation can leach nitrogen just as well as excessive rainfall and a heavy irrigation followed by rain can be particularly harmful. Generally, limit irrigation to 1 to 1-1/2 inches per setting.

The question often arises, when should I start to irrigate? This question cannot be answered with a rule of thumb. When tobacco wilts even slightly, it is showing signs of moisture stress, however if you have 20 acres to irrigate and it takes 10 days to cover it, waiting until wilting starts may be too late.

A soil probe is a good tool to determine soil moisture conditions. If your soil appears to be getting dry well into the root zone, it is time to start irrigation. A soil probe is also useful to tell if you have irrigated enough. You should not hit a dry layer of soil with the probe after irrigation.

An important management point for irrigation -- don't put off setting up your system waiting for the expected shower. Some irrigation systems in Southern Maryland have stayed in the barn throughout the driest summers.

**Selection of Equipment**

There are a lot of choices to make when it comes to selecting types of pumps and equipment. P.T.O. pumps are the simplest and cheapest and will suffice on many farms. With motor driven pumps, you have a choice of gasoline, L-P gas, diesel and electric. Sprinklers range from small to acre guns and all seem to work satisfactorily. Look for items that can be potential labor savers in equipment--snap couple sprinklers, solid-set systems, underground main lines, traveler systems, etc.

Research using trickle irrigation on Maryland tobacco began in 2002.

Section VI

## DISEASES OF TOBACCO

Plant diseases can reduce the quantity and quality of a crop produced. A sound disease management program that helps to minimize losses begins with the identification of the potential disease problems. The organisms that cause tobacco diseases are fungi, bacteria, viruses and nematodes. Many physical and chemical injuries produce symptoms similar to diseases on tobacco and are included in this section to help simplify the identifi-cation of the problem. The mere presence of plant pathogenic organisms is not enough to cause disease. Disease will only occur if the environmental conditions are right and the tobacco plant is susceptible at that time. It is because this combination is necessary for disease to occur that diseases can be managed through sound cultural practices, as well as through sanitation practices, and the use of chemicals and resistant varieties.

### Diseases caused by Fungi

#### Blue Mold

Blue mold is a leaf and stem disease that is caused by the fungus *Peronospora tabacina* that is highly weather sensitive and spread by air-borne spores. Cool, wet, and overcast weather favors the development and spread of the organism. Symptoms include circular yellow lesions, cupped leaves, and gray or bluish downey mold on the lower leaf surfaces. The disease was a seedbed problem in Maryland for years. Prior to 1979, blue mold would disappear from beds as soon as it would turn warm and dry in the spring, leading many to believe that it was not a major threat to field plantings. In 1979 a new form of the fungus appeared. The new form tolerates a wider range of growing conditions affecting plants throughout the growing season with leaf lesions and systemic stem infections. Any time during the growing season when cool and damp weather appears the disease can become active again and cause severe problems. Blue mold is now considered one of the most destructive diseases in tobacco.

Sporangiospores of the blue mold fungus are released and float in the air like fragile balloons and spread long distances by the wind. These spores are "usually" blown into Maryland from the south and infect unprotected plants in the seedbed and field. The initial symptoms appear about a week to ten days after infection as round yellow spots on the upper surface of the leaf. This lag time before symptoms appear is very important because infected plants lacking initial symptoms may be used inadvertently at transplant time. Under favorable conditions, the characteristic blue fuzz, a mass of new spores, develops in the infected spot but only on the underside of the leaf. Almost simultaneously, the disease can become systemic and grow internally throughout the plant. Systemic infections interfere with normal growth of the plant. In the seedbed and early field plantings, systemic infections cause malformed distorted buds and leaves, stunting, and can eventually lead to death of the plant. Surviving plants either remain stunted or have one-sided growth and can later fall over breaking off just above ground

level. Since 1979 we have learned a great deal about the biology of this organism that helps in understanding control recommendations.

- Spores are produced during night hours.
- Spores arrive during morning hours on air currents.
- In the presence of water, spores germinate and infect in 2 to 4 hours.
- It takes 5 to 7 days before symptoms appear on an infected leaf.
- Spores have a wide range of adaptation – 34 degrees F. to 95 degrees F.
- Spores are sensitive to direct UV light – most spores are then killed within 1 hour.
- Spores are seldom found viable on leaf lesions more than 72 to 96 hours old.
- The fungus over winters south of 30$^{th}$ parallel of latitude.
- Spores are spread by moving infected transplants as well as by air currents.

Blue mold is most devastating when it hits seedbeds and the diseased plants are transplanted into the field. The lag time between infection and symptom expression has led many growers to pull seemingly healthy plants from the beds only to find after transplanting both bed and field severely infected.

A new strain (race) of blue mold has developed resistance to the compound RIDOMIL. Pathologists tell us that both races (the earlier strain and now the new strain) exist in the environment but the predominant race is the one that has developed insensitivity to RIDOMIL.

Control

1) Do not purchase transplants from out of state. Each year, infected transplants are shipped into uninfected tobacco growing regions including Maryland. GROW YOUR OWN TRANSPLANTS!

2) Control measures must be season long and start in the plant beds and greenhouses. Apply DITHANE DF at the rate of 1 teaspoon per gallon of water every 5 to 7 days and start when plants reach the size of a dime. Spray for thorough coverage.

3) When the threat of blue mold is eminent, apply DITHANE DF at the rate of 1.5 to 2 pounds per 100 gallons of water as a foliar spray weekly. Utilize a volume of water for thorough spray coverage.

4) ACROBAT MZ may be applied at a maximum of 2.5 pounds of product per 100 gallons of water. Final prepared spray mix will increase from a minimum of 20 gallons per acre for small plants up to a maximum of 100 gallons for large plants.

5) Cultural: Destroy seedbeds as soon as transplanting is completed. Disk or plow stubble after harvest. Keep tobacco stalks off of seedbeds and fields where tobacco is to be planted.

Tobacco growers can monitor the movement of blue mold spores by visiting the North American Plant Disease Forecast Center at North Carolina State University. The website address is: http://www.ces.ncsu.edu/depts/pp/bluemold/. Visiting this site several times each week during blue mold season allows the tobacco grower to review a forecast that gives the anticipated future track of released blue mold spores, weather conditions over the region and along the forecast pathway, and an estimate of potential disease spread over the next two-day period. Reports are archived so you can go back and review previous documents.

**Black Shank**

Black shank is caused by the fungal species *Phytophthora parasitica var. nicotianae* that only attacks tobacco. This disease is a very serious root and stalk rot problem in the field but is also known to occur in plant beds. Visible disease symptoms are generally not manifested in the plant beds until high soil temperatures are reached. As a result plants without symptoms transplanted from the beds can be a very important source of infection in the field. Symptoms of this disease are drooping of leaves, general wilting of plants even when soil moisture levels are high, and main roots that have black lesions. As the disease progresses all leaves on an infected plant droop, yellow and eventually die. At this late stage, splitting the stalk will show a blackened pith that is separated into disks that look like stacked poker chips. This disease is soil-borne and is spread by movement of soil on equipment, through soil water or water courses in a field, and by movement of infected plant tissue. It is generally more severe in low spots or poorly drained areas that remain wet.

Control

1) Selection of varieties with resistance: MD 609 is resistant to the prevalent race of black shank and MD 40 has a high tolerance for this disease. Maryland's two most recent releases, MD 601 and MD 402, also have resistance to the prevalent race of black shank.

2) Cultural: When infection occurs isolation of infected area and areas below or in the drainage area help to prevent further spread of the disease. Move away from areas (fields) with black shank. Spores remain dormant for years and the re-introduction of tobacco in those areas will only witness a black shank disease outbreak.

3) Chemical: When susceptible varieties of tobacco are planned to be grown in areas where black shank has been a problem, RIDOMIL GOLD EC applied at 1½ quarts per acre pre-plant incorporated can be used. Control is not 100% but suppression of the disease does seem to occur at the higher rates.

## Black Root Rot

Black root rot is caused by the fungus *Thielaviopsis basicola* and occurs in both the plant bed and field and causes slow growth, stunting and yellowing of infected plants. Only the roots are actually infected and these are blackened to varying degrees. Diseased plants that are pulled out of the ground often appear to have only short stubby roots with blackened tips. The rotted sections easily break off and are left in the soil. There is no stem damage and no other characteristic symptom that is helpful in field identification of this disease. Only with microscopic examination can positive identification be achieved.

The fungus that causes black root rot grows over a wide range of conditions, is very persistent in the soil and can infect many other plants especially soybeans. Greatest disease development occurs when soil temperatures are still somewhat cool, 65-70 degrees F, and soil moisture is high. Symptoms, however, are more dramatic on hot days when the plant's demand for water cannot be met by the reduced root system. A soil pH level below 5.6 greatly reduces black root rot development. This effect is not due to pH alone but is believed to correspond to reduced availability of nutrients to the fungus.

Control

1) Selection of varieties with resistance: None of the Maryland varieties are completely resistant to black root rot. However, MD 609 and MD 201 have a moderate level of resistance.

2) Cultural: Maintain pH near 5.6. In problem fields, stalk and root destruction after harvest and crop rotation will help reduce the soil-borne fungal population responsible for this disease.

## Anthracnose

Anthracnose has been a common plant bed problem for Maryland tobacco. This disease is caused by the fungus *Colletotrichum gloeosporioides* but species vary widely and consist of many strains. During long periods of humid conditions the disease can develop into a serious problem in the field. Infections occur on leaf blades, veins and midribs, and also on stems. Initially the lesions are small sunken spots that appear water-soaked; these eventually dry out leaving white to tan paper thin spots. Large numbers of lesions can cause distorted growth of the leaves and in very wet areas can lead to the complete decay of the plants. The disease develops over a wide range of temperatures but requires high humidity and wet conditions for severe development. The fungus infects a wide range of plants including numerous common weeds found in and around tobacco plant beds and some vegetable plants.

Control

1) Chemical Control: A protectant fungicide spray is at present the only direct control

measure available. Apply DITHANE DF at the rate of 1 teaspoon per gallon of water and apply starting when the plants reach the size of a dime. Spray weekly for thorough coverage.

2. Cultural: Weed control in and around plant beds as many weeds are host and act as a reservoir of the fungus. Destroy old garden sites and locate vegetable areas away from tobacco beds.

3. Controlled watering to reduce wet and humid conditions in beds will also reduce the risk of disease development. Locate tobacco beds so sunlight hits the beds for a major portion of each day.

**Target Spot**

Target spot is a recently discovered disease that may have been misidentified in the past. In Maryland this disease is more prevalent in the plant beds than in the field. However, like all other plant bed problems it can easily be introduced into the field by infected transplants and thus become a more economical problem. The initial symptoms of target spot are similar to anthracnose or brown spot. As the small lesions on the leaves expand, the centers of the lesions remain brown like brown spot. Eventually, the lesions have a characteristic concentric ring pattern that resembles a "target" and the centers of the lesions often become brittle and fall out. The fungus that causes target spot, *Rhizoctonia solani*, is the same one that causes soreshin in seedlings. Target spot requires moderate temperatures, and periods of high relative humidity and leaf wetness, whereas, soreshin can occur under lower moisture conditions.

Control

1) Chemical Control: A protectant fungicide spray is at present the only direct control measure available. Apply DITHANE DF at the rate of 1 teaspoon per gallon of water and apply starting when the plants reach the size of a dime. Spray weekly for thorough coverage.

2) Cultural: Reduce periods of free moisture in plant beds by irrigation management and ventilation. Disease-free transplants should be used in the field.

3) Controlled watering to reduce wet and humid conditions in beds will also reduce the risk of disease development. Locate tobacco beds so sunlight hits the beds for a major portion of each day.

**Damping-off**

Damping-off is a disease of germinating seedlings that is caused by various soil-borne fungi, *Pythium* and *Rhizoctonia* being the most common two. Most damage occurs when

soils are cool and wet. Seedlings can be attacked at or below the soil surface immediately after germination to several weeks after emergence. Some of the organisms that cause seedling damping-off can also cause lesions on older tissue at the soil line. This condition is sometimes called soreshin, and the most common causal agent of this disease is *Rhizoctonia*. Infected plants that are transplanted grow slowly and can break at the soil surface under windy conditions.

Control

1) Cultural: Excessively wet soils should be avoided. Reduced seeding rates and good ventilation will also help in reducing the risk of this disease. Disease-free transplants should be used whenever possible.

2) Chemical: RIDOMIL GOLD EC now has a label for conventional plant bed applications for *Pythium* control applied at the rate of ½ pint per acre (or ¼ fluid ounce per 150 square yards). No applications can be made to any float system including outdoor beds or greenhouses.

**Brown Spot**

Brown spot has not been a major problem in Maryland in the past, but recently has been increasing in prevalence. The fungus *Alternaria alternata* causes the disease. Symptoms are leaf lesions that have concentric rings giving them a target-like appearance. Lesions can develop on plants in the plant bed, but usually only after warm weather has set in and thus is found more commonly in beds that are kept for late transplants or replants. In the field this disease begins on the lower leaves, with lesions progressively increasing in size and spreading upward on the stalk. This disease is sensitive to weather conditions, being favored by warm overcast days and high humidity.

Control

1) Cultural: Complete stalk and root destruction reduces the buildup of the pathogen. Use disease-free transplants. This disease develops faster in a stressed crop so control of other diseases, nematodes, and reduction of other stresses like over fertilization will reduce the severity.

**Fusarium Wilt**

This disease was very common in the past, but at present is no longer considered of major importance. The fungus causing the disease is known as *Fusarium oxysporum f. sp. nicotianae*. All presently released Maryland varieties have tolerance to this disease. However the organism that causes this disease is very persistent in the soil. Under the right conditions it may reappear and become a serious problem again. Typically this disease produced a wilt that begins on one side of the plant. Stripping the outer bark of the stalk reveals discolored tissue

on the side of the wilt.

Control

1) Selection of varieties with resistance – all presently released Maryland varieties have good tolerance to this disease.

## Diseases caused by Bacteria

### Angular Leaf Spot and Wildfire

Angular leaf spot and wildfire are bacterial leaf diseases that can occur in both the bed and field. These two diseases are caused by a variant of the same bacterium *Pseudomonas syringae* pv *tabaci* differing mainly in that one produces a toxin that causes halos to appear around the lesions and the other does not. Wildfire lesions are typically small tan to brown necrotic spots surrounded by a yellow border or halo. Angular leaf spot lesions are similar in color and size but do not have the halo and sometimes appear more angular as they are outlined by small leaf veins. Large numbers of lesions can develop and coalesce killing whole sections of a leaf. Many of these necrotic areas get tattered and even fall out in windy weather. High humidity and heavy rains are essential for severe disease development as this assists in the spread of the bacteria and creates temporary water soaked leaf tissues. Low potassium levels combined with high nitrogen levels are also known to enhance the water soaking and thus enhance disease development.

Control

1) Selection of variety with resistance: MD 40, MD 341, MD 402, and MD 601 are resistant to wildfire.

2) Cultural: Avoid unintentionally creating water soaked leaf tissue from over-watering plant beds and imbalanced N:K fertility.

3) Chemical: AGRI-MYCIN 17% (Streptomycin) foliar sprays are effective; however streptomycin tolerance has been found in Maryland. Bordeaux or other copper compounds may be used as substitute sprays.

### Granville Wilt

This bacterial wilt disease is not a very common disease in Maryland, but it occurred on some farms in 1993. It is caused by the bacterium *Ralstonia solanacearum* with symptoms somewhat similar to fusarium wilt, as the wilt is commonly one-sided. However, the discoloration that occurs just beneath the outer tissue of the stalk often has dark lines running vertically in it. The pith also can become discolored in sections and even slimy from the bacterial decay. In advanced stages the roots become dark brown to black and somewhat

shiny. High temperatures enhance the development of the disease.

Control

1) Cultural: Stalk and root destruction after harvest and crop rotations with non-host crops like corn, soybeans or grass pastures for several years are necessary to reduce the pathogen population that resides in the soil.

**Hollow Stalk**

Hollow stalk is a late season disease that generally only causes minor losses. The bacteria's causing the disease is a common soilborne soft rotting organism. Infection occurs through wounds at topping and is favored by warm humid conditions. Severe disease development can cause the center of infected stalks to be completely rotted. The bacteria can then spread into the midribs of attached leaves and can continue to cause rot in the barn.

Control

1) Cultural: Avoid topping on damp cloudy days especially with soiled hands or gloves. If the number of infected plants is limited, avoid topping those plants by hand and remove tops with shears; or, leave in field.

## Diseases caused by Viruses

**Tobacco Mosaic Virus (TMV)**

Tobacco mosaic virus infection produces stunted plants with a light green to yellow mottling in the leaves. Many other virus diseases produce this mottling symptom so it is not diagnostic for TMV, but the mottling symptoms are unique to viruses and genetic abnormalities in plants. Severe strains of the virus can also cause the infected tissue to die, producing leaf lesions similar to many fungal and bacterial leaf spots. Losses due to mosaic may run as high as a 30% reduction in yield alone. Early infections greatly reduce the quality of the crop as well. TMV can occur in the plant bed and field. Bed infections usually do not show symptoms. The virus survives for long periods of time in tobacco trash and unrotted roots from previously infected tobacco crops. TMV also infects ground cherry and horse nettle, common weeds in Maryland. TMV is present in most tobacco products, particularly those that contain any flue-cured tobacco in them. As a result there are many sources of the virus and because this disease is very easily transmitted by contact; e.g. leaves touching soil or infected trash, or even pulling plants while smoking or chewing tobacco; careful management is required to maintain virus-free plants.

Control

1) Selection of variety with resistance: MD 40, MD 201, MD 341, MD 402, and MD 601 are resistant to this disease.

2) Cultural: Strict sanitation - remove or plow under old plants in beds and maintain good weed control. Remove debris from barns and stripping sheds. Avoid spreading tobacco stalks on ground to be planted in tobacco. Wash hands with soap and water before weeding or pulling plants in the bed.

**Etch**

Tobacco etch is a highly variable disease that has been slowly building up in Maryland. As with most plant diseases caused by viruses, severely infected plants are stunted. The leaves of infected plants exhibit a mild mottling, clearing around the veins, and have small chlorotic spots that later die. These dead spots appear as small white flecks similar to weather flecking and are the reason for the common name "etch" given to this disease. This virus disease is spread principally by aphids, and has a fairly wide host range including peppers and tomatoes and common weeds like jimsonweed and lambsquarter.

Control

1) Cultural: Aphid transmitted viruses are very difficult to control. Aphids have to merely taste the plant to effectively transmit the virus. Field aphid control is therefore only effective at reducing the spread of the virus in fairly large fields. Eliminate weed hosts in and around the tobacco field and avoid growing tobacco near pepper or tomato fields.

**Ring Spot**

Ring spot virus is occasionally found in small patches, but does not appear to cause significant economic damage to Maryland tobacco. The symptoms are fairly distinctive as the infected leaves exhibit line patterns of chlorotic and necrotic tissue. These line patterns follow the veins of the plant and frequently become circular between the veins. Severely infected plants will be stunted. The host range for this virus includes ragweed, dandelion, horse nettle, ground cherry and pokeweed, as well as, quite a range of crop plants. This virus is spread by the dagger nematode, and several groups of insects and by mechanical contact. Mechanical spread though is not as dramatic as with mosaic.

Control

1) Cultural: Remove plants that have symptoms before topping. If topping, avoid plants that have symptoms to reduce chance of mechanically spreading the virus, then return and remove plants with symptoms. Good weed and insect control

reduces disease development. Sample soils for nematode populations to determine the need for control of this vector.

**Tomato Spotted Wilt Virus (TSWV)**

A virus disease known as Tomato Spotted Wilt Virus (TSWV) was found in Maryland for the first time in 2002 on farms in St. Mary's and Prince George's Counties. It is highly probable that this virus disease appeared in all tobacco producing counties in the State of Maryland.

TSWV first appeared in Georgia in 1986. Since then it has been a major field disease in the flue-cured regions of Florida, Georgia and southern South Carolina. The virus is spread by thrips. In tobacco the major vector is known as the Tobacco Thrips (*Frankliniella fusca*). However, the Western Flower Thrips (*Frankliniella occidentalis*) may be a vector here in Maryland as well. TSWV is picked up by juvenile thrips feeding on host plants with the virus. TSWV may be spread by both juvenile and adult thrips. In tobacco adult thrips are believed responsible for most infection.

Leaf symptoms include necrotic banding along and around the main veins, target ring spots, leaf twisting with symptoms only on one side of the mid-rib, and/or general necrosis of bud leaves. Early in the season the lower stalk may show a dark sunken stem resembling soreshin. Later in the growing season black streaks may be seen moving down the stalk from infected leaves. Plants, after infected, may develop these symptoms on one side or the entire stalk producing rapid wilt, yellowing, and death.

Presently Maryland tobacco growers must rely on what the flue-cured region has learned in dealing with this disease. Three general conclusions on this disease are known.

- TSWV can occur in plant beds or plant houses but several research projects have made no conclusions between plant sources and the final incidence of the disease.
- Secondary spreading is due to juveniles feeding on infected plants in the field and furthering disease spread as they move about as infected adults. Research results to date suggest TSWV arising in this manner is not as significant as initial infection.
- Most infections that lead to symptom development and plant death apparently occur right after transplanting.

Growers should be advised at this time there is no control known that is 100% effective. Current recommendations made during transplant production season include the pesticide ORTHENE 97P that is considered somewhat effective against tobacco thrips. In the field, flue-cured recommendations include a combination of ADMIRE 2F plus ACTIGARD. **However, Actigard is not registered for use in Maryland.** Growers are strongly encouraged to apply ADMIRE 2F utilizing the float tray drench procedure or

transplant water application technique. Rescue treatments utilizing registered tobacco insecticides are not recommended since most infections occur right after transplanting. Research results to date from the flue-cured tobacco growing region document the ineffectiveness of rescue treatments.

It is important to know that information is not readily available in Maryland on the effectiveness of these treatments. Remember, 2002 was the first year that we have known this disease to develop in our tobacco-growing region. As we learn more about TSWV and the control of the thrips vectors, information will be passed along to the county agricultural Extension agents in the tobacco producing counties.

Control

1) Cultural: Rogue host plants such as weeds, ornamentals, nursery, and vegetable plants away from tobacco producing area.

2) Chemical: Apply ORTHENE 97P to transplants in conventional plant beds, greenhouses, and outdoor float beds. This does not guarantee 100% control.

3) Chemical: Apply ADMIRE 2F at 1 ounce per 1000 plants or PLATINUM at 1.3 ounces per 1000 plants as a float tray drench 24 hours prior to transplanting in the field. Trays must be removed from float water prior to treatment. Refer to pesticide label for specific instructions.

**Diseases caused by Nematodes**

Nematodes are microscopic worm-like organisms that live in the soil. The plant parasitic ones feed and reproduce on or in the root system of plants. Because nematodes reside in the soil, their buildup and spread is relatively slow. The nematode problem appears first as small patches of land where tobacco doesn't grow well. Plants in these areas are stunted, occasionally chlorotic and the yield is reduced. These patches seem to get bigger just about every season.

The size of the nematode population and the particular species of nematodes must be determined in order to positively identify the problem. This can only be done in taking a soil sample for nematode analysis. The only exception is diagnosis of the root knot nematode. Root knot, as the name applies, produces small but visible galls or knots on the root system of infected plants. Knots usually can be seen with the naked eye.

Whenever nematodes are suspected, soil and root samples should be taken for positive identification. Early fall, before disking, is the best time to take samples. Soil samples should be taken from around the root systems of several plants growing poorly and placed in a plastic bag. Unhealthy plants with roots and soil intact should also be submitted. Care should be taken when submitting whole plant samples not to strip the soil from around

the roots. This rasping could scrape potential nematodes off of the roots and be missed during laboratory analysis. Another sample from an area of the field where the plants are apparently healthy should be taken for comparison. The soil and plant samples should be handled like living material. Do not allow samples to cook on the dashboard or bed of the pickup by setting in direct sunlight. Take your samples to your Extension office so they can be submitted to the laboratory for analysis.

Control

1) Cultural: Crop rotation is the best means of keeping nematode populations below damaging levels. Several tobacco references claim that fescue grass used in rotation helps to deter nematode populations.

2) Chemical control may be necessary if population levels are high and rotation is not possible. The following products are registered in Maryland for field application. Consult the product for specific application instructions.
   a) NEMACUR 3 – 1 1/3 to 2 gallons per acre pre-plant incorporated (ppi)
   b) TELONE II – 12 gallons per acre (ppi)
   c) MOCAP EC – 1 to 2 gallons per acre (ppi)
   d) VYDATE L – 1 gallon per acre (ppi)

## Injuries and Other Disorders

### Chemical Injury

There are cases of chemical injury to tobacco in Maryland every year. These generally fall into one of the following categories:

1. Contaminated Equipment - Sprayers, water tanks, etc. Chemicals such as atrazine are extremely toxic to tobacco. This material is heavier than water and will tend to settle in hose lines on sprayers and cling to rust inside of tanks. 2,4-D type weed killers are also difficult to clean out of sprayers and will also cling to rust and rubber hoses.

2. Drift - The ester form of 2,4-D type chemicals will vaporize and can move some distance from where it is sprayed even on relatively calm days. If absolutely needed on the farm, use the low volatile ester or amine form of 2,4-D on tobacco farms and use these with caution but never close to tobacco. This type of injury shows up as thickened malformed leaves with the outside edges of the leaf turned down and looking like saw teeth. In older tobacco the stalk will sometimes split and look like it is filled with buds.

3. Soil Contamination - This can occur from washing and rinsing pesticide equipment or leaving residuals from careless application. Heavy concentrations of atrazine type materials have killed tobacco 3 to 4 years later. Be particularly careful about possible contamination of your beds. There have been cases of beds being wiped out from atrazine being applied up hill

from them. Plants injured from atrazine will develop almost white areas on the leaves. These will later dry up and the plants die. In the case of old spills or when the chemical is deeper in the soil, symptoms may not show until the plants are large.

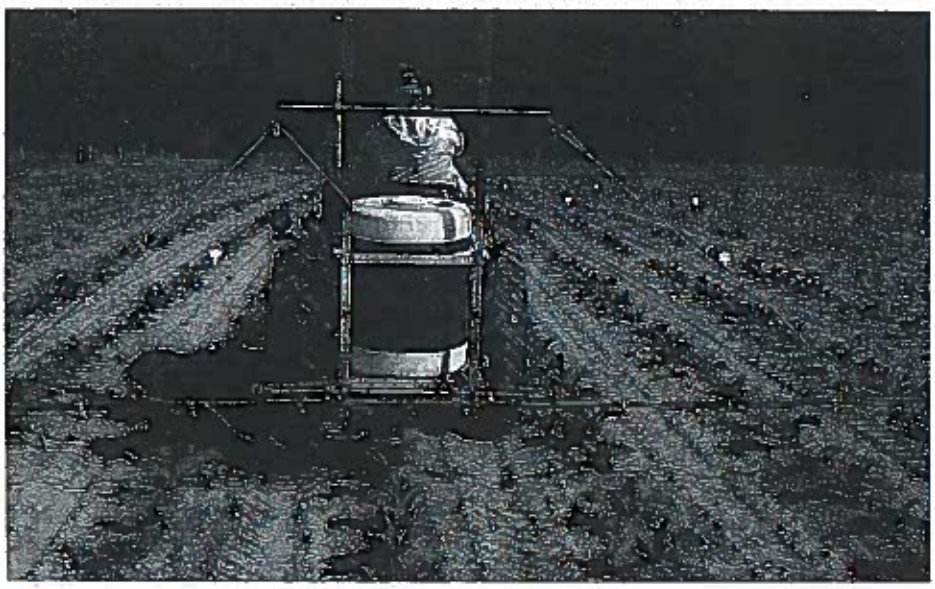
**Other Injuries**

1. Lightning Damage - This abnormality is quite often noticed in Southern Maryland during summer months. Of course, it must follow an electrical storm within a few days. Symptoms are wilting, discoloration to include blackened areas of veins and stalk and darkened pith. Lightning strikes usually occur in a circular irregular pattern. Lightning damage is quite often confused with Granville wilt or black shank.

2. Drowning - Following heavy rainfall or rainfall coupled with poor drainage, leaves on field plants will flop down. If drainage is not almost immediate plants yellow and die.

3. Root Pruning - Root pruning may cause excessive wilting when cultivating too close to plants. Larger plants are easily affected, particularly around last cultivation. The situation is aggravated with high temperature and low soil moisture. Some plants will not recover. In any case severe damage is sustained.

4. Weather Fleck (Injury from Air Pollutants) - Some years Weather Fleck is a problem in Maryland. It shows up on the older more mature leaves as small white flecks. In later stages the leaves fire and are lost. It can be one of the major contributors to firing leaf loss in Maryland in periods of high air pollutants. Maryland 609 appears to be more susceptible to weather fleck damage than other varieties.



A healthy tobacco field requires spraying which must begin early.

Section VII

## INSECTS ON TOBACCO IN THE FIELD

The chemical industry remains active in formulating, testing, and labeling new products for insect control on tobacco. Over the past 6 years more chemicals as insecticides have received registration for use on Maryland tobacco than any other category of pesticides. Each year the Maryland Tobacco Improvement Foundation publishes a listing of approved pesticides for tobacco in that current growing season. Table 12 shows insecticide products labeled for Maryland tobacco in 2004. Comments regarding insects and treatments follow the table.

Table 12
Field Insect Control, Maryland Tobacco, 2004

| Product | Target | Rate/Acre | Method | DTH 3/ |
|---|---|---|---|---|
| Actara | Aphid<br>Flea Beetle | 2 to 3 fluid ounces | Post | 14 |
| Admire 2F | Aphid<br>Flea Beetle<br>Wireworm | 1 to 2.8 fluid ounces per 1000 plants | Float tray drench or transplant water | |
| Dipel DF 1/ | Cabbage Looper<br>Budworms<br>Hornworms | ½ to 1 pound | Post | 0 |
| Fulfill 50 WDG | Aphid | 2.75 ounces | Post | 14 |
| Lannate LV | Aphid<br>Cabbage Looper<br>Flea Beetle<br>Budworms<br>Hornworms | ¾ to 1 ½ pints | Post | 14 |
| Lorsban 4E | Cutworm<br>Wireworm | 2 to 3 quarts | PPI | |
| Mocap EC | Wireworm | 1 to 2 gallon | PPI | |
| Orthene 97P | Aphid<br>Cabbage Looper<br>Cutworm*<br>Flea Beetle*<br>Budworms<br>Hornworms | ¾ pound | Post<br>*Transplant water | 3 |
| Phaser 3EC 2/ | Aphid | 2/3 to 1 1/3 quarts | Post | 5 |

| Product | Target | Rate/Acre | Method | DTH 3/ |
|---|---|---|---|---|
| Platinum | Aphid<br>Flea Beetle<br>Wireworm | .8 to 1 1/3 fluid ounces per 1000 plants | Float tray drench or transplant water | |
| Provado 1.6F | Aphid<br>Flea Beetle | 2 to 4 fluid ounces | Post | 14 |
| Sevin 80 WSP | Budworm<br>Hornworm | 1 ¼ to 2 ½ pounds | Post | 0 |
| Vydate | Flea Beetle | 1 gallon | Transplant water | |

1/ Many B.T. Compounds Available

2/ To minimize cured leaf residue problem, do not use at or after topping in Maryland.

3/ Days To Harvest (Label statement regarding days to wait from last application until first harvest.

Insect Note Pad

Wireworms - These pests enter the plant through the roots and are found in the shank of the plant. Where present, plants lack vigor, are stunted and may die. Apply treatments only to land with a definite history of wireworm problems. The click beetle is the adult of the wireworm.

Cutworms - Found just below the ground surface, these worms cut off newly set plants at the ground level and feed on the tops at night. Expect heavier populations when tobacco fields selected for production come from rotation with sod, cover crops, and legumes.

Aphids - These soft bodied insects are found principally on the lower side of the leaves where they suck the sap from the leaves leaving a honey dew or sticky residue that may be followed by a sooty mold. The red tobacco aphid is more prolific and can withstand higher temperatures than the green peach aphid. Do not let populations of aphids on your crop get ahead of you. Start observations for aphid infestation early, about the last of June. Spray when 20% of plants are infested with aphid colonies at any position on the plant.

Hornworms - There are normally two broods of hornworms per year; June-July and August - September. However, in some years they appear to be present throughout the season. They are found on the leaves and in their 3 week life span can consume as much as 336 square inches of leaf web - roughly 3.5 times the size of this page.

READ AND FOLLOW ALL DIRECTIONS ON THE LABEL OF ALL CHEMICALS THAT YOU USE

When to Spray: Count worms at least one inch in length without parasite cocoons.

| Plant growth stage | Spray when |
|---|---|
| Before button | At least 10 worms per 100 plants |
| After button | At least 20 worms per 100 plants |

Budworms - Damage results in crooked and ragged leaves when these worms are found in the bud area or central unfolding leaf. The same insecticides that are used for hornworms are effective against budworms. Budworms are often difficult to kill. Spray in the morning when tobacco buds are more open. Target all sprays directly over each bud. If first brood budworms are heavy, 2-3 applications will probably be necessary with power sprayers.

When to spray: Count only worms 1/2 inch or longer.

| Plant age in field | Spray when |
|---|---|
| 3-4 weeks | 4% of plants have 1 or more worms |
| 5 weeks | 10% of plants have 1 or more worms |
| 6 weeks | 20% of plants have 1 or more worms |

Flea Beetles - Other than the cutworm, this is one of the first insects tobacco growers may encounter at the beginning of the season shortly after transplanting. Flea beetles puncture tobacco leaves leaving pinholes and a leaf with a sieve-like appearance. These insects seem to be more of a problem on lighter soil types that warm up earlier in the spring. Dry weather promotes their feeding activity. Consider using transplant water treatments but caution must be practiced because over application may cause stunting of tobacco.

Cabbage Looper – These worms will sometimes cause damage in tobacco fields and in particular when tobacco follows or is close to other crops the cabbage looper favors. On drier years this worm can be found migrating from drier vegetative material to plant material that is green and actively growing. They normally eat leaves on the bottom of plants. Sprays for hornworms and budworms will be effective against cabbage loopers.

**General Spraying Procedures for Tobacco**

1) Set nozzle level 12 to 18 inches above plants.
2) Use a minimum of 8 gallons of mix on small tobacco. Use 30 to 50 gallons per acre on tobacco over 2 feet high.
3) Pressure should be 60 to 100 psi for aphids and 40 to 60 psi for other insects.
4) Solid cone or hollow cone nozzles are generally used at 1, 2, or 3 nozzles per row. Drop nozzles can be added for larger tobacco to help with thorough spray coverage.
5) To avoid illegal pesticide residues in cured leaf, be sure to follow the days to harvest guideline (allow that amount of time to lapse between application and harvest).

Section VIII

# TOBACCO TOPPING, SUCKER CONTROL AND HARVESTING

## Topping

The natural function of a tobacco plant after growing to maturity is to produce seed. In the final stages of growth all of the energies of the tobacco plant are so directed. When the tobacco plant is topped, however, the major effort of seed production is halted and the plant is forced back into vegetative growth. Since we are interested in leaf production and not seed production, topping is a very necessary function. Topping at the proper time increases weight of cured leaf by slowing down firing and by causing greater expansion of the top leaves.

## When to Top

It is best to top Maryland tobacco in about the early bloom stage. This would be when approximately 60% of the plants are showing some open flowers.

## Height to Top

The top should be removed to a level that results in a top leaf about 14 inches long. This would apply both in wet and dry years because more leaves will be removed with the top in dry years leaving less total leaves to mature. If there is evidence of second growth, the plants should be topped below this level because this is impossible to cure.

## Suckering

Tobacco that is topped at the right stage will develop suckers before it is ready to harvest, if there is ample plant food and water. These suckers in most cases have to be removed by hand before cutting or they can cause problems by continuing to grow in the barn. The removal of suckers by hand can be a very time consuming process during the harvesting period when labor is short. Because of this, most growers are now using chemical sucker control.

## Chemical Sucker Control

There are three types of sucker control chemicals: systemics, contacts, and the newest contact systemics. All have been tested and found to work satisfactorily on Maryland tobacco. When used properly, these chemicals will control sucker growth and in most instances increase yield per acre.

## Using the Systemic Chemical - MH (maleic hydrazide)

Maleic hydrazide is the most widely used sucker control chemical on Maryland

tobacco. It is sprayed on the upper actively growing leaves of the plant and taken into the plant. The chemical is moved by the plant to regions of sucker development where it stops their growth. Plants should be in a good active state of growth when they are sprayed. Problems with sucker control may develop if plants are hardened by drought or maturity. For best results the chemical should be applied when the humidity is high, normally in the morning, and within 24 hours of topping. Avoid spraying late in the evening when dew is forming or early in the morning if heavy dew is present.

General Precautions:

1. Read the label carefully and use only the recommended rate and application procedure to get best results and to keep cured leaf residues low.

2. Remove all suckers over 1 inch long when topping.

3. Do not allow the tobacco to stay in the field too long after the chemical is applied. Allow the plants to ripen properly before harvest, but do not let the tobacco stay in the field for prolonged periods after it is ripe. This will often cause heavy bodied, slick leaves in the top of the plant. Normally tobacco should be left in the field about 2 weeks after the application of the chemical to ripen properly, but avoid letting the tobacco stay in the field much over 3 weeks before harvest.

4. Rainfall can reduce the effectiveness of the chemical. If rainfall occurs within 2 hours after application, it will be necessary to reapply. See label for information regarding reapplication.

5. Maleic hydrazide treated tobacco tends to hold more moisture in the cured leaf. Care must be taken to dry out this tobacco before putting it in the bale.

6. Drain out your spray tank and flush with water before spraying other chemicals on younger tobacco. Extremely low rates of MH can cause severe damage to top growth of younger tobacco.

**Maleic Hydrazide Residues**

The following table shows information regarding two years of testing rates and method of application of maleic hydrazide. Sucker control was excellent with all MH treatments with no significant differences in yield. However, Quality Index was lower with increased rates of MH and residue levels almost doubled with 3 gallons and tripled with 2 applications compared with the recommended rate of 1.5 gallons per acre.

Table 13
Yield, Quality Index, and MH Residues when Comparing Three Different Application Rates and Methods on Maryland Tobacco

| Maleic Hydrazide Treatments | Yield Per Acre | Quality Index | MH Residues (PPM) |
|---|---|---|---|
| Recommended 1.5 Gal/A | 1,963 | 60 | 52 |
| Double Rate 3 Gal/A | 1,917 | 54 | 93 |
| 2 Applications 1.5 Gal/A One Week Apart | 1,970 | 51 | 143 |
| No Chemical | 1,563 | 45 | <1 |

## Using the Contact Chemicals

There are several contact type sucker control chemicals on the market. Each has a different active material and should be mixed and applied according to the instructions on the label. Contacts have to be applied so that the chemical runs down the stalk and hits each sucker bud where the leaf joins the stalk. Thus, the chemical has to be applied directly over the stalk with a hand sprayer or with special nozzle set-ups on high clearance sprayers. The contacts kill the young buds in a matter of minutes, so rain is not a problem.

General Precautions:

1. Read the label and follow the recommended rate and application procedure.
2. For best results, apply at tight bud stage - before topping.
3. If the tobacco stalks are leaning from wind damage, straighten the stalks if possible before application.
4. Do not apply excess amounts of the material, some can cause rotting at ground level if the material concentrates there.

## Using the Contact Systemic Chemicals

Prime+ is the contact systemic chemical presently registered for use on Maryland tobacco. The method of application for the contact systemic chemicals is similar to the contacts in that the mix has to run down the stalk and contact each sucker bud. Time of application is at normal topping and all existing suckers one inch or longer should be

removed before application. The systemic activity of the chemical appears to suppress new sucker bud development and one application should control suckers until harvest.

For hand application of Prime+ mix 2.5 ounces per gallon of water and apply 1/3 to 2/3 ounce per plant depending on size of plant. One half an ounce of mix per plant would be about 260 plants per gallon.

Do not use excessive amounts of Prime+ because residues in the soil may react with some herbicides such as Prowl and increase early season cover crop stunting. Deep tillage and heavy disking are recommended if this is suspected or you have had problems in the past.

General Precautions:

1. Read the label and follow directions.

2. If stalks are leaning, straighten stalks if possible before application.

3. Rainfall soon after application can reduce effectiveness - see label.

Table 14 shows sucker control chemicals registered in Maryland for 2004.

Table 14
Sucker Control, Maryland Tobacco, 2004

| Product | Type | Rate/Acre | Method | DTH |
|---|---|---|---|---|
| Off-Shoot T | Contact | 1.5 to 2 gallon in 48 gallons of water (4.5 fluid ounces in 1 gallon of water) | Post (By hand) | 7 |
| Prime + 1/ | Contact/Systemic | 1 gallon in 49 gallons of water (2.5 fluid ounces in 1 gallon of water) | Post (By hand) | 7 |
| Royal MH-30 2/ | Systemic | 1.5 to 2 gallons in 40 to 50 gallons of water | Post | 7 |
| Butralin 3/ | Contact | 3 to 4 quarts in 50 gallons of water (1.5 to 1.75 fluid ounces in 1 gallon of water) | Post (By hand) | 30 |

1/ May be used in sequential application with MH-30.
2/ Allow 14 days after application to harvest for lower ppm residues.
3/ May be used in combination with MH-30.

Sucker Control Notepad

Butralin – This product is the newest sucker control material to become available for use on Maryland tobacco. Maryland research played a major role in its labeling for use in combination with MH-30 and in the premix known as Stifle. Additional research in Maryland has shown that when this product is used alone, or in combination with MH-30, with a spreader sticker, sucker control is quick acting and effective. One-half inch rainfall within 2 hours after application does not reduce its effectiveness. Uses of this product in combination with MH-30 can help keep residue levels of maleic hydrazide below 80 ppm.

- Top plants in late button to early bloom stage. Remove any visible suckers at time of topping.
- Tank-mix 1 gallon MH-30, ½ gallon Butralin, and 12 ounces of surfactant Matrixx, Eth-n-gard, Sylgard 309, Motion, Biosurf, Silwet L-77, or X-77) in 50 gallons of water for each acre making sure the solution is thoroughly mixed before application. Butralin will give the solution a bright yellow color. Use protective gloves and clothing during mixing and application.
- Use a 3-nozzle arrangement over a single row with two TG-3's as laterals and a TG-5 in the center position. Apply at 18 to 20 psi with constant mixing during treatment applications. This will permit a showering of the solution over the upper third of the plant and the solution will run down the stalk making contact with leaf nodes.
- The restricted entry interval (worker protection standard) for Butralin and MH-30 is 12 hours.

Prime+ - Maryland research has shown that broadcast applications produce increased levels of USDA color grades V (greenish) and G (green). It is suggested to utilize this product in down stalk application techniques only. This method is very effective.

Maleic Hydrazide – Domestic and foreign tobacco companies are concerned with the over application of MH-30 and the potential for high residues in cured leaf (reported in parts per million). The goal for Maryland leaf is not to exceed cured leaf residues of 80 ppm. Proper application and waiting at least 14 days before starting harvest are critical to achieving this goal. Rainfall and/or irrigation during ripening also play a major role in helping the top leaf grow out and minimize potential residues.

## Determining Ripeness

Probably one of the most talked about phases of Maryland tobacco culture is the age-old question of "when is tobacco ripe"? There is no surefire answer to this question. It is the aim of the tobacco farmer to cut his tobacco at the time when it will yield, upon curing, the most bright grade tobacco. Cutting too early will result in greenish dull and too late a larger percentage of seconds. The methods for determining when tobacco is at the proper stage for cutting are learned most easily through actual experience. Some pointers to look for are:

- Color of plant - a ripe plant normally has a lighter green color than a plant that is actively growing. This is not true with MD 609 that grows with a lighter green color.

- Hardness of stalk - A plant that is still actively growing has a soft stalk, but as this plant starts to ripen, the stalk becomes woody. This hardness of stalk can be checked by hand. If the stalk cracks when a twisting force is applied, normally the plant is ripe.

- Hardness of leaf - Like the stalk, the leaf also becomes hard and brittle upon ripening. The popping of the leaf veins is an indication of the hardness, but it depends a great deal on the time of day.

All of the above pointers are indications that the plant is not actively growing; therefore, these symptoms may show when plant growth stops for reasons other than the plant approaching ripeness. These would normally be lack of water or lack of fertilizer.

## Cutting and Hanging

Maryland tobacco is stalk cut and the plant normally allowed to wilt before field spearing or hauling into the barn for barn spearing. Caution should be taken not to bruise the leaves or allow them to sunburn while you are waiting for the plant to wilt.

Sticks of tobacco are normally spaced 9 to 14 inches apart on the tiers in the barn. The exact distance depends largely on the size of the tobacco plants, variety and prevailing weather conditions.

## Harvesting Aids

There are several types of harvesting aids being used in Maryland. One type simply mechanically cuts the plants and others cut and convey plants back to a wagon or trailer for loading or spearing. All harvesting aids save labor. Tests with cutting machines show they save a minimum of 3 to 4 working hours of labor per acre at the critical harvest period.

Cutting Machines

The lawn tractor cutter is the most popular harvesting aid in Maryland. It was designed by Walter Bowling, Jr. of Charles County about 1973. This machine cuts one row of tobacco at a time and lays it on the ground. It can go between the average rows of tobacco with little or no damage and allows the plants to fall in the space of the row. This machine can cut 1 acre per hour.

The University of Maryland developed a one row tobacco cutter that is mounted on the front end of a Gravely hand tractor. This cutter is patterned after one of French design, but constructed for Maryland conditions. This cutter can also be equipped with a notching blade for suspending plants on wire for curing. The design of this cutter enables it to cut plants that are partially leaning. The cutter is self guiding in the row and can cut about 3/4 acre per hour.

Mr. R. C. Zantzinger of Charles County designed and patented a 4-row tobacco cutter that is mounted on a high clearance frame. This cutter throws plants in two "heap" rows with an "open" row between. This machine also has a stick carrier for dropping sticks.

Cutting and Loading Machines

Cutting and loading machines are popular in some areas. These machines are P.T.O. operated and either pull behind or 3 point mounted. The machines cut the plants and convey them back to a wagon or trailer between foam padded belts. The tobacco plants are loaded on the wagon for spearing in the barn.

Considerations with Harvesting Aids

1. Most machines need at least a 38 inch row width.
2. Ridging of plants at last cultivation can cause problems with most small cutters.
3. Do not throw tops and suckers on missing hills in the row.
4. Skip-row planting is desirable in larger fields when using the cutting and loading machines.

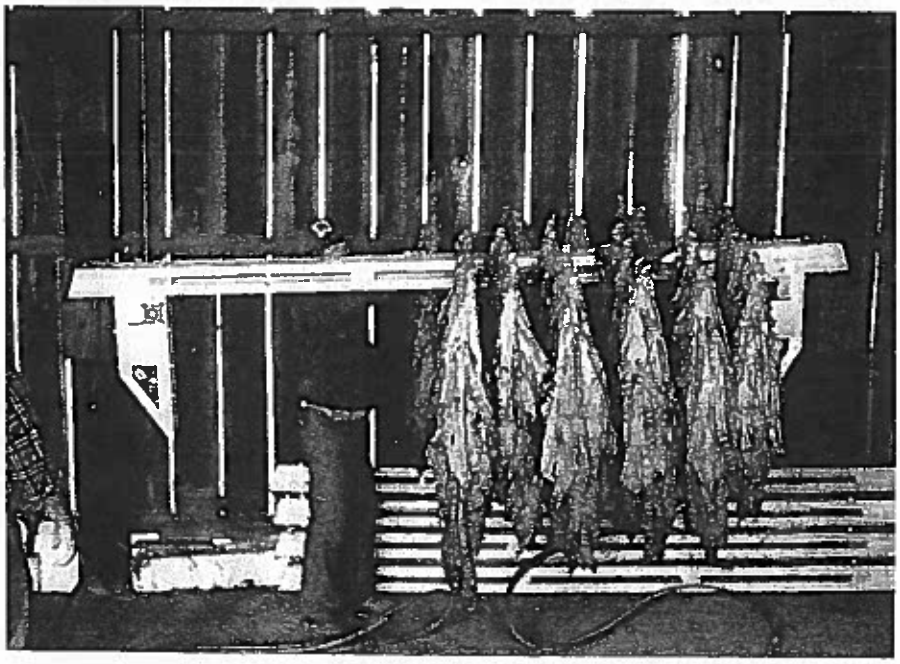
**Mechanical Barning of Tobacco**

A cable hoist system for mechanically barning of sticks of tobacco was developed by engineers at the University of Kentucky. This system was tested satisfactorily in Maryland and is now being used at the Research Station and installed on one farm in Prince George's County. In both cases, standard tobacco barns were modified for use with the cable hoist system. Sticks of speared tobacco are inserted into beams and the beams are "pushed" up in the barn by two hydraulically operated wenches that wind up the cable suspended from the top of the barn. The beams are placed in position in the barn and the wenches are lowered for hoisting the next beam. One man can carry out this operation from the ground. Beams can either be loaded in the barn or carried on trailers to the field for loading, thus

even more minimizing the labor necessary for barning. Mechanical cutting and the use of the cable hoist system reduces total working hours for harvesting and barning Maryland tobacco by over 30%. This system also increases safety in that it is no longer necessary to work at heights above ground level in curing barns. A recent study shows that one person can harvest and barn about 11 acres of Maryland tobacco in the harvest season using mechanical cutting and the cable hoist and beam system.

**Note** - Complete information on costs and procedures is contained in the publication **The Conversion Of Maryland Tobacco Barns To The Cable Hoist System,** Tobacco Information Bulletin No. 1, Maryland Tobacco Improvement Foundation, 1994.

A cable hoist beam being loaded with tobacco for the cable hoist system.



Section IX

## PRINCIPLES AND MANAGEMENT FOR CURING MARYLAND TOBACCO

### Curing Process

The moment the tobacco plant is cut in the field, the curing process begins. The plant has been cut off from its food supply and has to live on the reserve stored in the leaves and stalk. As this reserve is used up, the plant goes through two stages before being completely cured. The first stage is the yellowing stage. During this stage the starch and sugars in the leaf disappear, the nitrogen compounds change and plant materials move from the leaf to the stalk. This starvation process must take place to produce high quality tobacco. The second stage is the browning stage. During this stage, the cells in the leaf die and turn brown in color. After the leaf color has been set the remainder of the process is the removal of water from the leaf, a strict drying process. Normally, both stages will be occurring at the same time in the plant.

A tobacco plant will have a moisture content of approximately 86% when cut. Therefore, of the 11.7 tons of total weight per acre, 10 tons will be water or about 2,400 gallons. If this tobacco is allowed to wilt completely in the field, but not sunburn, it will lose up to 18% of its initial green weight. This loss will amount to 2.1 tons. Removing this water helps in handling and hanging the tobacco. However, it also helps in the curing in that the plant will begin the dying process quicker. It will begin to yellow faster and also reduces the chance of soft rot and houseburn in the barn.

### Hanging

The method of hanging will vary from farm to farm, but certain facts should be considered. The space between sticks will depend on the size of plants, number of plants per stick, barn size, and time interval of filling the barn. The quantity of tobacco hung in the barn governs the amount of ventilation required. If a barn is filled completely within one week, the amount of ventilation required will be much greater than for a barn that is only partly filled each week.

Cool, moist air accumulates near the ground. If the bottom tier is not hung with tobacco, there will be better air movement near the ground. This can improve the general conditions in the entire barn.

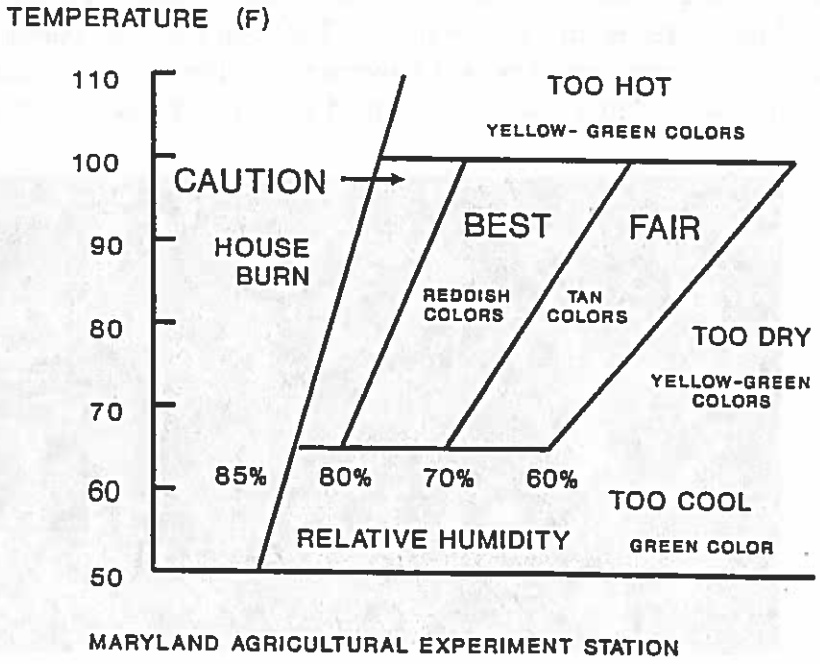
### Effects of Environmental Conditions on Curing

Environmental conditions within the barn largely determine the final quality of the cured tobacco leaf. Air-curing of tobacco is largely dependent on the weather (temperature, relative humidity and wind) and proper manipulation of the ventilator doors.

During curing, plants lose water and dry matter while slowly changing color from green to yellow to brown. If the leaf dries before it is completely yellow, chemical reactions are stopped and the leaf cures green or greenish in color. If the leaf dries too rapidly after yellowing, the leaf cures with yellowish to tan colors. These colors are not considered desirable for Maryland tobacco because they are an indication that the leaf cured too quickly before the necessary chemical changes took place. When the leaf begins to turn brown, drying is necessary to prevent damage and houseburn.

Research has shown that Maryland tobacco will cure the best colors if the temperature averages between 85 and 95 degrees and the relative humidity is just below 80 percent. Figure 2, Curing Conditions for Maryland Type 32 Tobacco shows the range under constant conditions that will give good results. This range covers conditions between 65 and 100 degrees F. and 60 to 80% relative humidity.

Figure 2. **CURING CONDITIONS FOR MARYLAND TYPE 32 TOBACCO**




The cured leaves on the bottom of plants hanging in the barn can be indicators of moisture conditions in the barn. These leaves should not be dry to the brittle stage except for short periods until all the leaves on the plants are cured. If the leaves are in good "order", the humidity is 80% or higher, and little if any drying will take place. If the handling condition of the cured leaves is fair, the relative humidity will be between 70% and 80%. If the leaves dry to a brittle condition, the humidity will be 60% or lower. However, for good curing conditions, these leaves should dry out at least once every 24 hours. A hand of cured tobacco hung in the barn where there is good air movement will also serve as a humidity indicator.

## Barn Management

Barn management is an important factor in producing the desired cured leaf colors for Maryland tobacco. Too many times barns are opened when cutting is started and closed when curing is completed. Pay close attention to the relative humidity conditions both inside and outside of curing barns. If the relative humidity is low outside and the tobacco in the curing barn appears to be drying too fast, close the barn to keep in as much moisture as possible. In most curing seasons there are times when barns should be closed. The most dangerous conditions are when the relative humidity is low and there is wind. This can cause fixing of color in the leaf regardless of the stage of curing. Under continuous periods of low humidity, in addition to keeping barns closed, it may be desirable to wet barn floors to get extra moisture. On the other hand, houseburn can occur under prolonged high humidity conditions. The natural progression of curing is that the leaf changes from green to yellow in color. The leaf cells then start to die and the brown colors develop. It is at this stage when moisture has to be removed from the leaf or rot causing organisms will start to grow and houseburn develops. Tobacco is in the most dangerous stage for houseburn when the bright grade leaves are turning brown. Continuous high humidity, around 90%, will result in houseburn if not corrected in 24 to 48 hours. The high humidity conditions that create houseburn can be corrected with heat and movement of drier air. A 10 degree increase in temperature will lower relative humidity about 25%. Air movement with fans will also help.

A good looking Maryland crop hanging in the barn.

Maryland tobacco normally cures very well under the normal daily alternating relative humidity conditions of the growing area. The humidity increases in the late afternoon and evening and remains high throughout the night and early morning. It starts to lower rapidly after sunrise and reaches its lowest level between 2 PM and 4 PM. This coming in and going out of "order", creates very desirable conditions for curing Maryland tobacco. Curing problems develop only if the relative humidity remains either too high or too low for a prolonged period of time.

Figures 3a and 3b show the weekly average relative humidity (RH) values recorded hourly for the 2002 curing season starting August 11th through October 5th. Each figure graphs 4 weeks and the average RH value on the hour for a 23-hour period starting at 7 am and ending at 6 am the following day. Research has shown that Maryland tobacco cures the best colors if the temperature averages between 85 and 95 degrees and the RH is between 70 and 85 percent. An ideal curing day is when the tobacco is subjected to high and low RH values causing the leaf to go "in and out" of order in a 24-hour period.

The figures show 5 good weeks for curing; the weeks of August 25 - September 7, and September 15 - October 5. The other 3 weeks had RH values in a very low range. Only for a minimal amount of time was the RH between the ideal 70 and 85 percent range. Barn doors during 2002 should have remained closed more often than open. Even better, and during the drier time periods, barn doors can be closed during the daytime and open at night.

The last week in July 1993 was examined more closely to see there was one particularly bad day - July 30. Figure 4 shows the average hourly relative humidity conditions and wind speeds for July 30. There were 18 hours in the day with the relative humidity below 70% and wind speeds averaged over 7 miles per hour from 9 a.m. until 7 p.m. during the very lowest relative humidity period. These are the type of conditions that could fix undesirable colors in the cured leaf and barn doors should be closed.

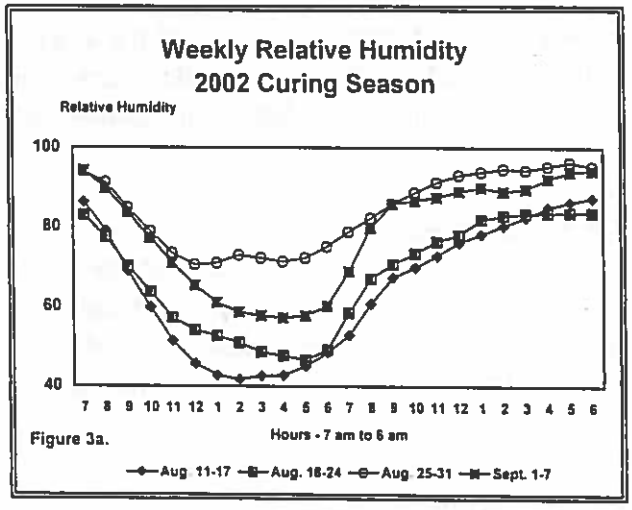


Figure 3a.

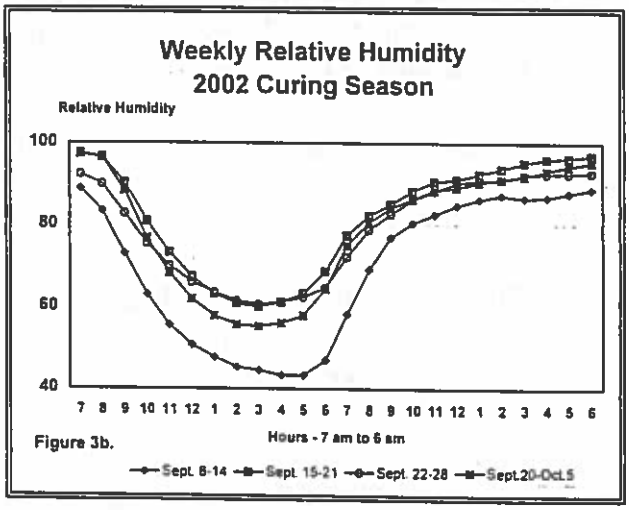


Figure 3b.

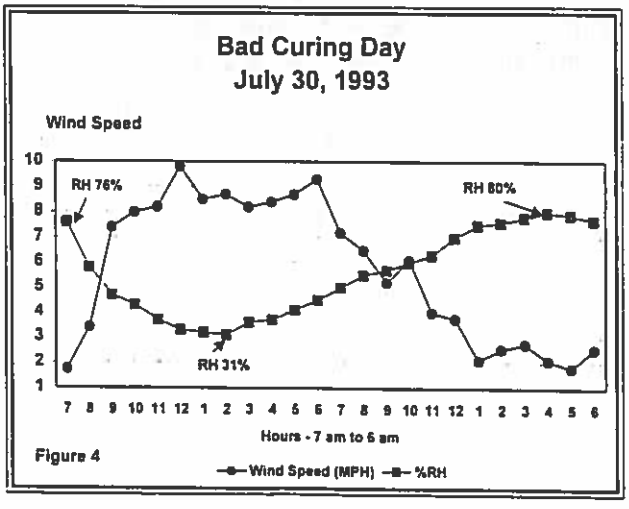


Figure 4

Section X

## STRIPPING, GRADING AND MARKET PREPARATION

Studies show that it takes about 100 hours of labor to process cured Maryland tobacco from the barn to the basket. Efficiency in this total operation is very important to stay in business. Minimize the manual handling of the tobacco as much as possible. Use pallets when moving tobacco from the barn to stripping room. If moisture conditions permit, basket as you strip. Try innovative ways to strip such as the stripping wheel method where you are free to remove leaves with both hands. Put stripped hands directly on sticks as you strip to minimize handling. Some growers use a stick holder mounted on their stripping table and others use a cinder block on the floor to hold sticks upright for loading with tied hands. Stalk and stick holders also help efficiency.

### Stripping Wheel

A farmer in Tennessee developed a rotating holder for sticks of tobacco for stripping. The top of the holder is "plus" shaped and the sticks are hung between the arms in holders at the ends. Leaves are stripped from the stalk while they are still on the stick. This allows the worker to use both hands to remove leaves, thus speeding up the process. The stripping wheel is probably most efficient when tobacco is baled because the leaves can be dropped directly into the bale box. However, it also is an aid in hand tying. A small table behind the worker to hold small lots of leaves and stick holders for the tied hands of the major grades works very well. A stripping wheel can be used by one person up to about three. Above this number of workers, a second wheel would probably be more efficient.

One person operation involves: First, loading the wheel with four sticks of tobacco. Second, removal of seconds grade rotating the wheel to get the leaves from the 4 sticks. Third and forth, repeat for bright and dull grades. Fifth, remove sticks and pull off stalks using a stalk and stick holder and continue the process. If two or three people are working, the various jobs are divided up according to quantity of tobacco in each grade and the skills of the workers.

A new design for a stripping wheel was made by farmers in Calvert County. This stripping wheel has a different method of operation. Pieces of 1 ½ inch plastic pipe are bolted perpendicular to a circular piece of heavy plywood. These are the stick holders and swivel on the bolt. This allows people to work between sticks rather than just on one side. This stripping wheel as designed has a 4 foot diameter plywood base and holds 20 sticks at a load. This design has some definite advantages, but requires more space for operation.

Advantages of the stripping wheel are:

1) Increase in productivity

2) Less tiring in that you do not have to lift the weight of the stalk particularly when stalks are still green. Also, you can move around and not be in the same position all of the time.
3) Tobacco can be held on the stick until stripping time.

Disadvantages of the stripping wheel are:

1) You have to be willing to stand on your feet while stripping to do the job.
2) Stripping rooms have to be wide enough to work around the wheel.
3) Good overhead lighting is essential.

**Stripping Tables and Lighting**

Lighting - Use 2 or 4 tube, 40 watt florescent fixtures alternating "daylite" and "deluxe cool white" tubes. Fixtures should be placed end to end over the stripping table or stripping area. Stripping tables should provide an area 4 feet by 6 feet per person as the minimum size necessary for efficient operation. The height of the table should be adjusted to suit the tobacco worker.

**Grading**

If tobacco is not uniform when you pull it off of the stick, separate out the off color or small plants from good plants for ease of stripping and handle separately. Strip tobacco in as many grades as practical. Separate all yellow and green tobaccos from the reddish colors in all grades. Keep tobacco clean (do not nest).

**Preparation for Market**

**Baskets**

Cut strings off of baskets before using with your crop. There is concern about the use of plastic twine and of fragments getting mixed into the tobacco. Do not pack tobacco in too high order. Tobacco should have a little "rustle" before packing. Make baskets appear neat and attractive. Keep baskets clean and true to grade. What a buyer can see and pull should be representative of the whole basket. Check all baskets for condition before taking them to market.

The condition of Maryland baskets has deteriorated over the years. Warehousemen are finding it harder to replace worn, broken, and destroyed baskets. More and more growers are turning to the "bale" as the preferred marketing unit for their tobacco.

## Baling Maryland Tobacco

SOME HISTORY -

Maryland tobacco growers are making a change in the way they prepare their tobacco for the auction markets. This gradual change from recent years has seemed to escalate in interest and activity. It is likely that in the next several years most (if not all) tobacco will be sold on the Maryland auction market in the form of bales versus hand tied. You might ask yourself "is this change unprecedented"?

A picture hangs on the wall of the Central Maryland Research and Education Center, Upper Marlboro Facility, showing the primitive mode of bringing tobacco to market in Virginia during the year 1829. It shows a hogshead being pulled on its side by horse and oxen. The tobacco in that hogshead was hand tied and for many years the hand tied leaf was the principal form of presentation. During the 20th century, gradual changes began taking place. These changes resulted in monumental differences in the way tobacco was being marketed. The flue-cured tobacco growers were the first to make changes. In the combined markets of Virginia, North Carolina, and South Carolina, the sale of untied leaf increased from 49 million pounds (3.7%) in 1962 to 728 million pounds (66.6%) in 1967, and approached 100% in 1970. This activity portrayed the emergence of flue-cured tobacco from hand tied to untied and sheeted.

Another shift is taking place in the flue-cured tobacco markets. In 1996 growers began experimenting with baling flue-cured tobacco in packages ranging in weight between 400 and 700 pounds. In 1998, over 150,000 bales weighing 700 pounds each have accounted for 12% of the total crop volume being sold in bales. This shift has continued into 2003, as the 700-pound bale is now the predominant package in contracted buying stations and remaining auction markets.

In 1970 it was predicted tobacco growers in the burley belt would remain marketing their tobacco as hand tied for the immediate future. However, after the flue-cured belt changed the burley belt began their gradual change. Approximately 25 years ago researchers in the burley belt began looking at marketing burley tobacco untied in a bale package. For the next 10 years research work was conducted on other alternative packages, the mechanics of putting up a bale, moisture content and bale storage ability, labor savings, and auction market acceptance. Warehousemen, graders, packers and tobacco companies critiqued and agonized over this major shift. Today virtually the entire burley tobacco crop is marketed in the bale package.

Work in Maryland began around 1968. Researchers evaluated the labor savings potential for not having to tie tobacco into bundles. They also evaluated several different methods of packaging untied tobacco for the market. These packages included the pressed bale, a burlap sheet, and a cardboard box. On June 15, 1969 a mock sale was held on the Maryland tobacco auction market allowing buyers, warehousemen, packers, dealers and

graders to inspect the different types of packaging and express their reactions.

A driving force bringing about this shift was labor savings. At the conclusion of his research work, Dr. George Duncan, Extension Agricultural Engineer, University of Kentucky, found that tying burley tobacco involved 140 worker hours or 41% of the crop time (total crop time representing 341 worker hours). This figure is very similar to labor figures that were proposed for Maryland tobacco production in 1971. One half of the total labor used by farmers in preparing Maryland tobacco involved preparation of the crop for market. Up to 150 man hours per acre were required for the average grower. There was no doubt that a major shift in the preparation and marketing of Maryland tobacco was strongly being considered.

PROBLEMS -

Since 1973 issues encountered with marketing Maryland tobacco untied in bales surfaced regularly. The price received for tobacco in bales was the number one concern in the early years. Some farmers felt that tobacco in the bales was discriminated against in price and was avoided by the European buyers. This has changed dramatically with the 1996 crop in bales receiving $2.00 per pound from our European customers.

Another concern has been the mixing of grades in the bale. Companies have been afraid that growers would strip faster and become more careless in mixing grades of leaf in the bale. Dry leaf damage was an issue that affected the tobacco companies as damage and loss of leaf during all dry periods would result in losses the tobacco companies would have to absorb. It was also necessary for the packers (in the burley years) and processors to retool their packaging and processing lines.

Warehousemen would also have to adapt to the handling of bales from the traditional form of marketing Maryland tobacco on a basket. In recent years with the deterioration of the wooden basket we now see evolving the use of slip-sheets, or cardboard packaging.

It became evident that Maryland researchers needed to address several issues in the marketing of Maryland tobacco in bales. Those issues were labor savings, the farm storage ability of bales, and the relationship of tobacco moisture during baling to leaf loss.

RESEARCH -

All of the research reviewed showed labor savings for the farmers when marketing tobacco in bales. In the burley tobacco market loose-leaf packaging options reduced the labor by 40% and the cost of stripping and marketing burley tobacco by 5-7 cents per pound.

In a test of individuals stripping Maryland leaf, it was shown that the untied leaf system was faster than the system of tying the leaves into bundles. The overall savings in time by

not typing leaves into bundles was 62 minutes per 100 pounds of stripped tobacco, which represented a reduction of approximately 22 percent in stripping time.

In a 3-year study, fall stripped Maryland tobacco was conditioned which resulted in a range of moisture contents from 11.8% to 34.7%. This tobacco was baled into 60 pound bales of the dimensions 12" deep, 24" high, and 36" long. The bales were weighed, stored in an unheated building and monitored with thermocouples. In the spring the bales were reweighed and evaluated for the condition of the tobacco. Evaluators were two buyers of Maryland tobacco who inspected and evaluated the condition of the tobacco in each bale over the study period.

All bales under 20.4% moisture at fall baling were in acceptable condition and all bales over 24.5% moisture were in unacceptable condition. The questionable range of moisture content for safe storage of bales of Maryland tobacco was between 20.4% and 24.5% moisture content. The development of heating in bales was an indication the tobacco was either in the questionable or unsafe range of moisture content for storage. Tobacco of high moisture content exposed to early spring warm temperatures heated resulting in an unacceptable condition of the tobacco. Some variability exists in leaf of the bright and dull grade reflecting that leaf body is a factor that contributes to heating.

It appears that fall stripped Maryland tobacco should not be baled with moisture content over 20% to be stored safely on the farm until marketing in the spring. Tobacco in marginally acceptable conditions ranging in moisture content between 20.4% and 24.5% should store safely as long as spring temperatures remain very low. Should rising temperatures elevate rapidly at any time, this tobacco may be in danger of heating. Tobacco over 30% moisture content should be expected to heat in the fall.

There was a positive correlation between moisture content at baling and weight loss during storage. Weight losses in this study ranged from .4 to 15.5%. The greater the moisture content of the tobacco during baling the greater the weight loss will be during storage. Bales packed with safe moisture content, 20% or less, had weight losses of less than 7%.

SUMMARY AND RECOMMENDATIONS -

Baling tobacco saves 25 to 40% of the total processing time. A small percentage of Maryland tobacco growers sell tobacco in bales. However, each year more of Maryland's tobacco growers are turning to baling tobacco for market preparation. Bales are a one-person package in that one person should be able to lift and handle them. The tobacco is packed directly and there is no re-handling. Bales are more compact than baskets and take less space to store. You can also haul more pounds of tobacco per vehicle load when going to market.

If Maryland tobacco growers want to continue to attract the European buyers using the bale package, standards will need to be incorporated into this market package. These

standards are necessary so that warehousemen can handle and sell the crop and foreign and domestic buyers can adequately evaluate their purchase intentions. Since Maryland is an undesignated market, current federal standards for the tobacco bale package do not apply. Some very good standards to follow are listed.

STANDARDS TO REMEMBER NOTEPAD

- Keep bales to a standard size: 12" in depth; 24" in height; and, 36" in length. Over-sized bales do not stack and handle uniformly at the warehouse or during shipping. Larger bales do not fit on the duckbills or baskets and create problems when wrapping in slip-sheets and banding

- Hold bale weights between 50 to 60 pounds. The bale is designed for a one-man package. When opened for inspection, buyers should be able to pull the tobacco apart easily for review. Any bale over 80 pounds is generally too wet, too big, or compressed too tight. Tobacco pressed too tight will not present itself well on the floor and appears bruised, slick and/or shiny, and caked when pulled apart.

- Use cotton twine only. Do not use plastic or sisal twine. Most 100 percent cotton twine sold for baling has a 150-pound tensile breaking strength. Use three pieces of twine, and no more to tie the bales package together.

- Butts of leaves should be oriented against the ends of the bale box. Avoid putting leaves in the center of the bale if possible. If baling tobacco with leaves too short in length to lap, use bunches of oriented leaves in the center portion to hold the bale together when tied.

- Tobacco suitable to basket is suitable to bale. Tobacco a little on the dry side can be baled satisfactorily. Avoid baling tobacco too dry, as shatter losses will be too great. Avoid baling tobacco with too high moisture.

- Mustiness begins when moisture is greater than 20%. When moisture is greater than 23%, expect heating problems to begin when outside temperatures begin to warm up. Tobacco in excess of 30% moisture will heat in the fall.

- Grade the tobacco going into a bale as you would going into a basket. Grade your tobacco as best you can for leaf position, color, and quality characteristics. Separate green or greenish (G and V) colors and yellow or mottled (K) colors. Tag each bale as to the grade.

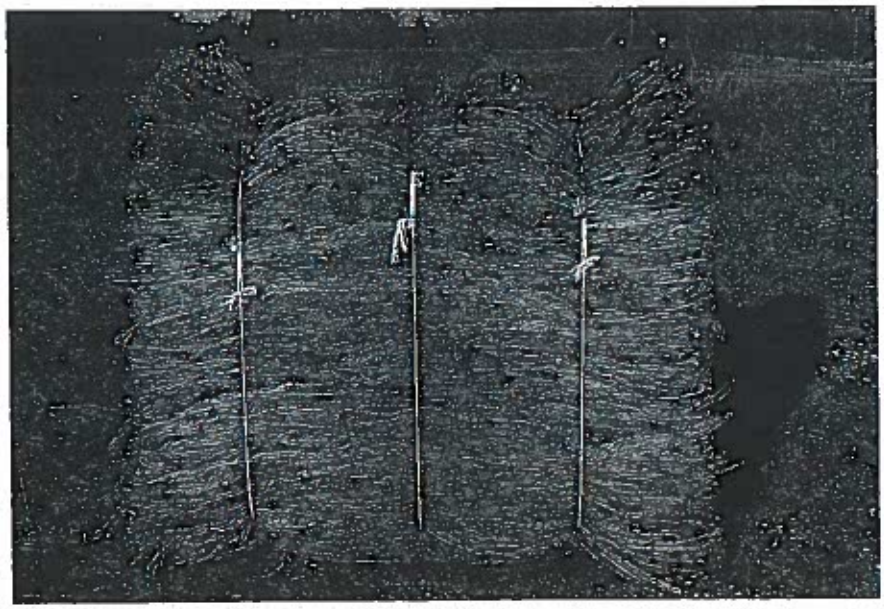
- Do not "nest" any tobacco by inserting foreign material (such as suckers, stalks, floor sweepings) or concealing inferior grades or quality in the bottom or inner portions of the tobacco package. According to Maryland State law, it is illegal to do this!

- After stripping, store upright with the butts exposed. Stack no more than two bales high in a protected but ventilated environment.

ALL PROBLEMS START RIGHT IN THE STRIPPING ROOM. TOBACCO GROWERS NEED TO EXERCISE CARE TO BE SURE THE TOBACCO BALE MEETS QUALITY AND UNIFORMITY STANDARDS FOR THE DOMESTIC AND EUROPEAN MARKET PLACE.

CONCLUSION -

The tobacco companies and industry leaders played a vital role in the transition of marketing all types of hand tied tobacco into an untied and loose-leaf format. There have been some levels of resistance to change over time on the part of the growers and industry itself. However, a common thread has prevailed with the tobacco companies willing to make a change for the benefit of the growers. In Maryland the slow evolution from the hand tied to the untied was very much an industry-controlled situation. It now appears that this transition is in the hands of the growers. Tobacco growers must do it right in order to keep open all European markets and domestic utilization.



A 60-pound bale of Maryland tobacco ready for market.

Section XI

# SOIL SELECTION AND CROP ROTATION

## Selecting the Right Soil for Tobacco

Tobacco is being grown successfully in Maryland on soils ranging in texture from deep sands to heavy silt. Soils that are considered best for Maryland tobacco are the loamy soils somewhere between these two extremes. A soil probe is a good tool for checking your soil conditions. Some important considerations in locating areas to plant tobacco follow.

## Best Soils

1. Level or only slightly rolling land is best. If you have to plant areas that are sloping, use contour strips to conserve both soil and water.

2. Areas with deep topsoil are also favored. Deeper soils will normally be more productive and respond better to fertilization and irrigation.

3. Look for fields with relatively uniform soil conditions. Good uniform soil will produce a uniform crop.

## Areas Where Problems May Develop

1. Hill sides should be avoided for tobacco production, if possible. Normally most of the topsoil has been lost from these areas and the potential productivity is low. Machinery is also difficult to operate on steeply sloping fields. If you are forced to use this type of land, use soil-conserving measures such as contour strip and long rotations.

2. The potential productivity of "clay knobs" and "gravel outcrops" is also low. It is best to leave these areas out of production, as they will not produce uniformly with areas of better topsoil conditions.

3. Woods' edges where trees "pull" from the field will seldom produce satisfactorily. Normally it is much better to leave a wide grass strip than to plant such areas in crop. Tobacco also is overly susceptible to aphid infestations in such shaded areas.

4. Known soil-borne disease or nematode-infested areas should not be planted if possible. However, often these areas can be brought back into production with the use of the right type of rotation.

5. Droughty soils or soils that consistently produce a poor crop in dry years should only be used where irrigation is available.

6. Tobacco cannot stand "wet feet". It will drown in areas that are wet or where water has any tendency to stand.

7. Soils with a hard pan will limit root penetration. Tobacco is a deep-rooted crop and if soil conditions permit the roots will grow vigorously 18 inches or more into the soil. Deeper plowing or sub-soiling can improve some fields with a plow pan, that is, a relatively thin compacted soil layer.

Factors other than soil may have a bearing on where you plant tobacco. For instance the nearest source of water for irrigation would be a deciding factor. It would be better to plant a field considered droughty, but for which irrigation was available, than a good field that your pipe will not reach. Some other considerations would be the ability to get in spray equipment, convenience for close watching and location relative to existing barns.

**One-Year Rotations or Cover Crops**

A good cover crop system provides some protection to the soil over the winter and early spring and adds organic matter and nitrogen to the soil. Small grains, wheat or rye are most commonly used for soil protection and organic matter. Vetch or crimson clover can be combined with any of these to supply nitrogen. However, there are often problems with stands being either too thick or too thin, and therefore you may have little control over the amount of nitrogen you put back into the soil. Also, many legumes will harbor nematodes and increase the number of these pests in the soil. A better way of getting the needed nitrogen is to apply nitrogen fertilizers to the small grain or grass cover crop. Excellent results have been obtained from applying 30-35 pounds of nitrogen per acre to the cover crop either shortly before or at plowing. Don't apply nitrogen too far in advance of plowing because your small grains may grow too quickly and get too "woody". When this is plowed under it will take a long time to rot and will do little good for the tobacco crop. Cover crops should be plowed under at least two or three weeks before heading.

**Two and Three Year Rotations**

Many years of study have shown that two and three-year rotations give higher tobacco returns than planting continuous tobacco with winter cover crops only. The longer rotations seem to be particularly beneficial in both wet and dry growing seasons. If you have enough good tobacco soil to be able to take it out of production for one or two years, you'll profit by using a two or three-year rotation. Therefore, if you plan to plant 10 acres of tobacco and have 20 acres of good soil, a two-year rotation would be more profitable than continuous tobacco. If you have 30 acres of good soil, a three-year rotation would be more profitable than continuous tobacco, although the three-year rotations haven't been any more profitable than two-year rotations in experiments to date.

The longer crop rotations help improve the physical condition of the soil as well as add organic matter and nitrogen. Rotations can also be designed to reduce the spread of

nematodes and soil-borne diseases such as black shank.

Two-year rotations - Some of the most commonly used two-year rotations are:

Tobacco - small grain - interseeded with lespedeza or red clover

Tobacco - red top, tall fescue or other grasses (tall fescue is particularly good if nematodes are a problem)

Tobacco - small grain (allowed to fall)

Tobacco can also be grown successfully after soybeans, corn, sudan grass, etc., but you do not get the full advantage of a longer rotation when the ground has to be plowed for the alternate crop. There is also potential for chemical residue problems from the previous crop. Check the label of the chemical you plan to use on a crop the year before tobacco to see if there are any residual problems.

Three-year rotations - This type of system is of most advantage where either soil conditions or slopes are such that plowing and clean cultivation should be done only infrequently. Most of the same systems listed for two-year rotations can also be used successfully in three-year rotations. Tall fescue seems particularly well adapted to the longer rotations. This will form a very dense growth and is an excellent competitor against weeds. However, because of the dense growth, plowing can be a problem. This grass has been used very extensively at the University of Maryland research station in Upper Marlboro.

Rotations of more than three years are of little advantage except in attempting to control black shank. If possible, areas infested with black shank should be left out of tobacco production for a minimum of four years.

A field of Maryland 341 grown in 2001.

Section XII

## CONSERVATION AND POLLUTION

We must do everything we can to reduce agricultural pollution of the Chesapeake Bay and its tributaries. Tobacco is a clean cultivated crop that is grown on soils that often erode easily. Much of the producing area is rolling in nature. Using good conservation practices in the production of your tobacco not only reduces soil and water loss, but also helps you produce a better crop.

### Contour Strips

Many tobacco farmers are using contour strips on their sloping fields, but many more should be using them. Contour strips work out very well in a tobacco farming operation. Fields are set up with alternating strips of tobacco and small grain, hay crop, etc. Strips are normally not too wide ranging from 50 to 120 feet depending on slope percent and length and equipment to be used in the farm operation such as irrigation and width of sprayers. One additional advantage to strip cropping growers say is psychological in nature. If you harvest one acre out of a ten acre field, it doesn't look like you have done much at the end of the day. However, if you harvest a one acre strip, that strip is finished and you can very easily see what you accomplished.

### Diversion Terraces and Grass Waterways

Run-off water from fields is a natural occurrence and if it is not handled properly can cause erosion, serious production losses, and other problems. Diversion terraces and grass waterways are an excellent way to handle this problem on most Southern Maryland farms where strips are not enough. Diversion terraces can be constructed to intercept run-off before it crosses cultivated fields causing erosion. Waterways can carry this water to an area of discharge where it will not cause problems.

### Soil Conservation Service

All of us have seen major erosion problems on farms corrected with the proper lay-out of good conservation practices designed by the Soil Conservation Service. There are many examples of this in Southern Maryland where mud from the fields no longer covers the road with every hard rain in the summer. Good soil and water conservation practices on your farm do not cost you money, they make you money and with present pollution concerns are a must. Contact your local Soil Conservation Service office if you need help on your farm.

### Environmental Pollution Concerns

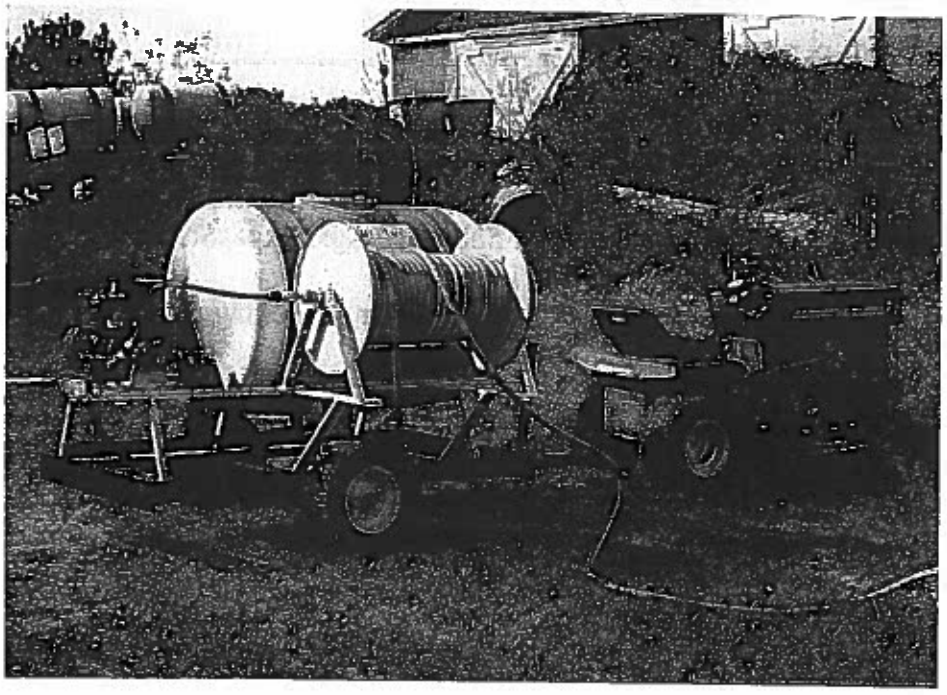
Agriculture's role in protection of the environment has gained prominence and public concern. With Southern Maryland's highly erodible soils, proximity to the Chesapeake Bay

and a growing influx of population, farmers in this area have to be particularly careful.

1. Pesticides - **Get and keep updated a Private Applicators Certificate.** This keeps you informed on the changing regulations concerning pesticides and allows you to purchase restricted use pesticides. Use only the recommended rates of labeled pesticides on your crops. Read the label carefully to be aware of any precautions about environmental hazards.

2. Fertilizers - Avoid using excessive rates of nitrogen and phosphate on your crops. Both of these plant foods are major concerns in pollution of streams, rivers, and the Chesapeake Bay. Nitrogen can also be a problem in ground water pollution.

3. Farm Nutrient Management Plans – The Water Quality Improvement Act of 1998 was enacted by Maryland legislators to regulate the use and application of inorganic and organic nutrients on agricultural lands. Participate with other farmers in your community and work with Nutrient Management Advisors and Consultants who write and develop these plans for your benefit and the benefit of the surrounding environment.



Pesticide application equipment for a greenhouse and outdoor float bed system.

Section XIII

## TOBACCO FARM EFFICIENCY

How do you stand in production efficiency? The yield per acre and the total hours of labor per acre range greatly from farm to farm. In an older study (*) it was found that yields could range 1000 pounds per acre from farm to farm. Some growers are still in the 700 to 800 pound per acre range whereas others produce above 1800 pounds per acre. Likewise in man hours to produce an acre, there is a range of over 100 man hours per acre. Some produce an acre of tobacco with well under 200 man hours and others are closer to 300 man hours. A very important point from this study was that the man producing in the 1800 pound per acre range is not the 300 man hours per acre man. He is producing this high yield with labor efficiency.

Following are 3 examples of farms studied. All 3 farms were using approximately the same amount of labor per acre, but yields were quite different. See how this influences the amount of production per hour of labor.

| FARM | Farm 1 | Farm 2 | Farm 3 |
|---|---|---|---|
| Hours Labor per Acre* | 231 | 227 | 237 |
| Yield - Pounds per Acre | 1019 | 1301 | 1788 |
| Pounds of Tobacco per Hour | 4.4 | 5.7 | 7.5 |

* J. Paxton Marshall and Billy V. Lessley, Allotment Distribution and Major Inputs Used in Producing Maryland Tobacco. M.P. 588, Md. Agr. Expt. Sta. 1966.

You can see from this example that the first point in getting efficiency in tobacco production is to get your yield up - within reason.

The second major point in efficiency is to keep your hours of labor to produce an acre of tobacco down. In the same study cited, it was found that it took an average of 219 man hours to produce an acre of Maryland tobacco. If you are well over this figure, you may be able to find better methods to help reduce your labor requirement. Some possible points to check in your operation are listed.

**Plantbeds**

- Do a good job of fall sterilization for weed control.
- Leave fumigation covers on over the winter so beds can be made earlier.
- Use an irrigation system for watering.

- Clip and undercut.
- Consider greenhouse or outdoor float systems of transplant production.

**Transplanting**

- Pack plants in containers as you pull.
- Transplant uniform plants.
- Use large water tanks - preferably gravity flow for filling transplanter.
- Consider skip-row planting.

**Field**

- Use low plant population levels for maximum production per plant.
- Use weed control chemicals.
- Use shields on cultivators for first cultivation.
- Top while plants are still tender.
- Use sucker control chemicals.

**Harvesting**

- Use cutting machines.
- Use large beds on wagons and trailers.
- For short hauls, load sticks of tobacco standing up on tails rather than load flat.
- Use low profile barns with driveways for every bent.
- Consider a mechanical barning system.

**Stripping**

- Use of pallets - Take down tobacco from barn and put on pallets; move into stripping room - no rehandling of sticks.
- Basket or bale as you strip - no rehandling of tobacco.
- Design a stripping room that has better working conditions. Use fluorescent lights, tables, and have a good safe heating system in the stripping room - better working conditions.
- Doors for the stripping room should provide large openings for the movement of pallets or equipment used in moving large quantities of tobacco.
- Humidify the stripping room so that you can bring tobacco into order.
- Try a stripping wheel where sticks are hung up and you can pull leaves with both hands and individual stalks are not handled. Some growers have hangers for sticks in their stripping room. The stripping wheel involves a rotating frame to hold sticks for stripping.
- Baling saves 25% to 30% of the time required to strip and prepare tobacco for market compared to hand tying.

Section XIV

## CALIBRATION OF FERTILIZER AND SPRAY EQUIPMENT

Farming today requires the use of many technological advantages research has provided to properly nourish and protect your plants. Precision is necessary to keep expensive costs down both from the use of excess materials and because of the injury that might be sustained due to excesses. To be precise the equipment used in applying chemical fertilizers, insecticides, etc., must be accurate. Accuracy is obtained by calibrating your equipment before using.

The following information and data may be helpful to you from that standpoint.

### How To Use the Accompanying Chart and Calibrate Equipment

1) Determine the rate per acre desired (pounds, bushels, ounces, pints, quarts or gallons).

2) Measure the linear distance required making up either 1/4th or 1/20 of an acre as is indicated in the chart.

3) Fill the drill, spreader, or sprayer tank to the top, level (use only clear water when calibrating a sprayer).

4) Set the fertilizer hoppers, drill or spreader as manufacturer indicates or according to markings on equipment, for the quantity desired.

5) Cover the required linear feet as measured off in (2) above. In the case of the sprayer the pressure and ground speed must be kept constant. If PTO speed is varied, volume will be varied.

6) After distance required is traversed, stop and refill equipment level to the top, keeping count of the bags, bushels, gallons or pounds of material required to refill.

7) If you are using column A or B (see next page) multiply total pounds used to refill by 20 to get the acre rate that you are applying. If you are using equipment in Column C, D or E, multiply by 4 to get the acre rate applied.

8) Having found out what you are applying you must adjust upward or downward to the desired level, by changing cogs, pressure, or other settings.

| | Linear Feed to Cover 1/20th Acre | | Linear Feet to Cover ¼ Acre | | |
|---|---|---|---|---|---|
| | A | B | C | D | E |
| Width of Equipment | 3- 16 Inch Plows | 1 Row Cultivator | Grain Drill | Fertilizer Spreader | Sprayer |
| 4 Feet | 545 | | | | |
| 36 Inch Rows | | 726 | | | |
| 38 Inch Rows | | 688 | | | |
| 40 Inch Rows | | 654 | | | |
| 42 Inch Rows | | 622 | | | |
| 8 Feet | | | 1361 | 1361 | |
| 10 Feet | | | 1089 | 1089 | |
| 12 Feet | | | 908 | 908 | 908 |
| 21 Feet | | | | | 519 |
| 28 Feet | | | | | 389 |

**EXAMPLE (Fertilizer):**

You would like to spread fertilizer, broadcast at the rate of 1000 pounds per acre in your 8-foot spreader.

Using the figure in Column D, we know that 1361 linear feet must be traveled, and in this 1361 feet (which is the length of 1/4 of an acre 8 feet wide) we should apply 250 pounds of fertilizer (1000 divided by 4). You could travel 680 linear feet (1/8 of an acre) and apply 125 pounds of fertilizer; or, you could travel 340 linear feet (1/16 of an acre) and apply 63 pounds of fertilizer.

Lay off the distance required in one long strip, or depending on the length of the field, one or more round trips.

**EXAMPLE (Pesticide):**

In the case of the spraying equipment, once the acre rate of liquid being applied is determined, the pesticide may be added as recommended. If 25 gallons of water are being delivered per acre and 1 pound of pesticide is needed per acre, and the tank holds 150 gallons,

add 6 pounds of pesticide to the tank for a mix that will treat 6 total acres.

**Conversion of % to Parts Per Million (ppm)**

% equals parts per 100, to convert to ppm take % times 10,000.

**EXAMPLE:**

To make 50 gallons of 100-ppm streptomycin spray from 17% streptomycin material as purchased:

- 17% = 170,000 ppm (17 x 10,000)
- Thus 1 ounce of 17% streptomycin will require 1700 ounces of water.
  (170,000 ppm divided by 100 ppm = 1700)
- 1700 ounces of water = 13-1/4 gallons (1700 divided by 128 ounces per gallon)
- One ounce of 17% streptomycin will make 13-1/4 gallons of 100-ppm spray.
- To make 50 gallons of spray you will need about 4 ounces of material.
  (50 divided by 13-1/4)

**LIQUID MEASURE**

| UNIT | Ounces | Tablespoons | Teaspoons | Milliliters- cc |
|---|---|---|---|---|
| One level teaspoon | | | | 5.0 |
| One level tablespoon | | | 3 | |
| One fluid ounce | | 2 | | 29.57 |
| One cup | 8 | | | |
| One pint | 16 | | | 473.2 |
| One quart | 32 | | | 946.3 |
| One gallon | 128 | | | 3785.0 |

**WEIGHT MEASURE**

One ounce = 28.3 grams
One pound = 454.0 grams or 16 ounces

**LAND MEASURE**

One acre = 43,560 square feet or 4,840 square yards

## Conversion Factors for English and Metric Units

| To Convert Column 1 into Column 2, Multiply by: | Column 1 | Column 2 | To Convert Column 2 into Column 1, Multiply by: |
|---|---|---|---|
| **Length** | | | |
| .621 | kilometers, km | miles, mi | 1.609 |
| 1.094 | meters, m | yards, yd | 0.914 |
| 0.328 | decimeters, dm | feet, ft | 3.048 |
| .394 | centimeters, cm | inches, in. | 2.540 |
| **Area** | | | |
| 0.386 | kilometers$^2$ km$^2$ | miles$^2$, mi$^2$ =640 A. | 2.590 |
| 2.471 | hectares, ha | acres = 43,560 ft$^2$ | 0.405 |
| 10.76 | meters$^2$, m$^2$ | feet$^2$, ft$^2$ | 0.0929 |
| **Volume** | | | |
| 35.1 | meters$^3$, m$^3$ | feet$^3$, ft$^3$ | 0.0283 |
| 0.00973 | meters$^3$, m$^3$ | acre-inches | 102.8 |
| 2.838 | hectoliters, hl | bushels bu | 0.352 |
| 1.057 | liters | quarts, qt | 0.946 |
| **Mass** | | | |
| 1.102 | tons (metric) | tons (English) | 0.9072 |
| 220.5 | quintals, q, 100 kg | pounds, lb | 0.00454 |
| 0.0353 | grams, g | ounces, oz | 28.35 |

**Conversion Factors for English and Metric Units** - continued

| To Convert Column 1 into Column 2, Multiply by: | Column 1 | Column 2 | To Convert Column 2 into Column 1, Multiply by: |
|---|---|---|---|
| **Rate or Yield** | | | |
| 0.446 | tons (metric)/ha | tons (English)/acre | 2.24 |
| 0.892 | kilograms/hectare | pounds/acre | 1.12 |
| 0.892 | quintals/hectare | hundredweight/acre | 1.12 |
| **Plant Nutrient Conversion** | | | |
| 2.29 | P (element) | $P_2O_5$ | 0.437 |
| 1.20 | K (element) | $K_2O$ | 0.833 |
| **Temperature** | | | |
| 9/5 0° C +32 | Celsius, C | Fahrenheit, F | 5/9 0° F -32 |
| | 17.8 degrees | 0 degrees | |
| | 0 degrees | 32 degrees | |
| | 20 degrees | 68 degrees | |
| | 100 degrees | 212 degrees | |

Section XV

# WHY TOBACCO SAMPLE COLLECTION

## Introduction

Each year during the fall, county agricultural Extension agents, tobacco warehouse operators, and the Extension regional tobacco specialist, approach Maryland tobacco growers to participate in the University of Maryland's tobacco leaf chemistry analysis program. Leaf chemistry performed on tobacco leaf lamina is conducted to determine alkaloid and nitrogen levels on the Maryland crop prior to the market's opening day. Results of this testing serve as an indicator for the crops' chemistry quality and is used to promote the Maryland crop. Utilized in Extension's efforts with the Maryland Tobacco Improvement Foundation, results are shared with our domestic purchasers and our European customers around the world and serves to verify the existing crop's quality. The first "crop survey" was conducted on the 1967 crop and the 37th crop survey will be conducted on the 2003 crop. Maryland's tobacco growers are always urged to participate!

## Why Total Nitrogen and Total Alkaloids?

During the mid-60's importance was being placed by the tobacco trade on chemical content of tobacco being purchased throughout all of the tobacco marketing belts (flue-cured and burley). Air-cured tobaccos were being evaluated for total nitrogen and total alkaloids. Flue-cured tobaccos included total sugars along with nitrogen and alkaloids.

Dr. Orman E. Street, former tobacco researcher in 1967, stated the importance of total nitrogen and total alkaloids in tobacco. The content of total nitrogen is made up mostly of proteins, other complex protein-like compounds, nitrates, ammonia and alkaloid nitrogen. While these analyses do not tell the whole story from a chemical viewpoint, they furnish some basic information to the cigarette manufacturer. Total nitrogen gives an indication of the strength of the smoke. Very low contents of total nitrogen are associated with a weak or taste-less smoke, while high nitrogen often results in a strong smoke irritating to the eyes or nose. The intermediate amounts provide a pleasant full-bodied smoke most satisfying to the smoker.

Total alkaloids include small amounts of compounds other than nicotine, but it is possible to reduce their amount to an insignificant figure, and this is true of present Maryland varieties. This stimulation of relatively small amounts of nicotine observed from the smoke is probably the physiological basis for smoking. Present trends toward lower nicotine contents in cigarette tobacco and the smoke creates a demand for tobacco of rather low nicotine content. Maryland tobacco, because of its generally lower nicotine content, is useful to the trade as a means of balancing the higher contents of other types and be the lone constituent of a Maryland cigarette.

In 2002, 37 Maryland tobacco growers submitted samples for analysis of three stalk positions (seconds, bright, dull) for a total of 111 samples. We can look at the 2002 crop, and the previous 9 years, in Table 15, titled "10 Year Average Leaf Chemistry Analysis, Maryland Farmers Samples, 1993 to 2002. The 2002 crop year's data showed the dry growing season created harsh conditions for obtaining the type of leaf chemistry we want in our Maryland leaf. Yet, the previous 2 years (2001, and in particular 2000) buyers saw leaf that had good to excellent leaf chemistry. Not all of the growing seasons are the same. Droughty years can produce a crop that is always anticipated as questionable in quality. Data provided in such a crop survey doesn't provide surprises, but reinforces valuable marketing information that can be put to good use on behalf of the grower. Identification of individual growers is kept confidential.

Table 15. 10-Year Average Leaf Chemistry Analysis, Maryland Farmer Samples, 1993 to 2002.

| Year | % Total Alkaloids | | | % Total Nitrogen | | |
|---|---|---|---|---|---|---|
| | Seconds | Bright | Dull | Seconds | Bright | Dull |
| 1993 | 3.32 | 3.72 | 3.38 | 2.84 | 3.72 | 4.44 |
| 1994 | 2.25 | 2.96 | 2.95 | 2.96 | 3.55 | 4.00 |
| 1995 | 2.68 | 3.31 | 3.34 | 2.89 | 3.88 | 4.79 |
| 1996 | 1.44 | 2.49 | 2.49 | 2.74 | 3.45 | 3.96 |
| 1997 | 2.48 | 3.17 | 2.87 | 2.99 | 3.87 | 4.54 |
| 1998 | 2.66 | 3.67 | 3.42 | 2.94 | 3.86 | 4.79 |
| 1999 | 2.21 | 3.32 | 3.29 | 3.07 | 3.98 | 4.60 |
| 2000 | 1.55 | 2.36 | 2.41 | 3.13 | 3.57 | 3.96 |
| 2001 | 2.49 | 3.19 | 2.91 | 3.06 | 3.99 | 4.52 |
| 2002 | 2.62 | 3.52 | 3.32 | 3.43 | 4.28 | 4.96 |
| | | | | | | |
| Average | 2.37 | 3.17 | 3.04 | 3.00 | 3.82 | 4.46 |
| High | 3.32 | 3.72 | 3.38 | 3.43 | 4.28 | 4.96 |
| Low | 1.44 | 2.36 | 2.41 | 2.74 | 3.45 | 3.96 |

## Pesticide Residue Monitoring Program

Pesticide residue testing began in 1998 after a request to the Maryland Tobacco Improvement Foundation from the tobacco company members Philip Morris and B.A.T. Remaining members joined in the recommendation that Maryland's leaf be scrutinized, again like flue-cured and burley leaf, for illegal pesticide residues. Pesticide residue testing is a requirement and program component for tobaccos sold under the federal price support program. Also referred to as the Auction Warehouse Testing Program, 1 sample per 1 million pounds tobacco sold is sampled randomly for at least 15 different residues.

Currently funded entirely by DIMON, Export Leaf, and Universal Leaf Tobacco Companies, Maryland's volunteer program utilizes the above referenced farmer samples collected and sampled for the same compounds as for flue-cured and burley and added Acrobat, Dithane, Orthene, Prime +, Thiodan, and MH-30. Tobacco companies prefer all residues to be negligent, or, certainly well within approved USDA limits. The results from the most recent test show a clean bill of health and are found in Table 16.

Table 16. Test Results from the Pesticide Residue Monitoring Program for Maryland Type 32 Tobacco, Crop Year 2002. 1/

| Compound Detection Limit (ppm) | Dithane 1.0 | Prime+ 0.05 | Orthene 0.1 | Acrobat 0.5 | Thiodan 0.02 | MH-30 10.0 | USDA Import Pesticides List 3/ |
|---|---|---|---|---|---|---|---|
| Sample # | | | | | | | |
| 1 | BDL 2/ | BDL | BDL | | | 64.4 | |
| 2 | BDL | | BDL | | 0.025 | 244 | BDL |
| 3 | BDL | 4.97 | BDL | | | 197 | |
| 4 | BDL | | BDL | BDL | | 109 | |
| 5 | BDL | BDL | BDL | | | 128 | |
| 6 | BDL | BDL | BDL | BDL | | 84.4 | |
| 7 | BDL | | BDL | | BDL | 47.6 | |

1/ - Southern Testing and Research Laboratories, Inc., Wilson, North Carolina
2/ - BDL (Below Detection Limit)
3/ - 15 Additional Compounds such as DDT, Toxaphene, Dicamba, and 2,4-D.

## Tobacco Specific Nitrosamine Testing

In 2001 Maryland began testing for tobacco specific nitrosamines. Nitrosamines have been identified as one of the primary carcinogens in tobacco and are now an important issue in all tobacco types (especially flue-cured tobacco). Possibly a chemical by-product of tobacco combustion, nitrosamines are formed when direct fired curing gases yielding nitrous oxides come in contact with nicotine in curing tobacco causing these potentially carcinogenic compounds to be formed.

Concerns surrounding air-cured tobacco with high TSNA levels possibly associated with field applied nitrogen rates being too high and ventilation during curing are also evident. High correlations have been associated with high nitrogen rates and high alkaloid levels (mostly nicotine). When a lit tobacco product burns, nitrous oxides and alkaloids once again form these compounds.

Tobacco growing regions began testing several years ago. In an effort to keep Maryland's leaf on the forefront and to provide evidence that TSNA levels in Maryland

tobacco are low, farmer submitted samples were also subjected to tobacco industry supported TSNA testing. The results of those tests are found in Table 17. After reviewing the data, the reviewer can see that Maryland's air-cured tobacco is very low in total TSNA levels.

Table 17. Report of Tobacco Specific Nitrosamine Testing, Maryland Tobacco Farmer Samples, 2000-2002 Crop Years. 1/

| Year | Farmer 1 | Farmer 2 | Farmer 3 | Farmer 4 | Farmer 5 |
|---|---|---|---|---|---|
| | ppm | ppm | ppm | ppm | ppm |
| 2000 | 0.614 | 0.623 | 0.840 | 1.14 | 0.772 |
| 2001 | 0.363 | 0.649 | 1.460 | 0.291 | 1.620 |
| 2002 | 2.480 | 0.775 | 3.780 | | |

1/ - Southern Testing and Research Laboratories, Inc., Wilson, North Carolina

## Conclusion

The tobacco industry began early to request information regarding a region's crop characteristics prior to market day and began asking for tobacco chemistry information. Maryland tobacco industry leaders have followed other regions in providing the types of information asked for to show crop quality characteristics outside the norm of day to day business. In order to have Maryland leaf in front of all buyers, potential or otherwise, this information must continue to be made available for the industry's review and critique.

**MARYLAND'S TOBACCO GROWERS ARE URGED TO CONTACT THEIR COUNTY AGRICULTUAL EXTENSION AGENT AND SUBMIT SAMPLES OF THEIR TOBACCO FOR TOBACCO CHEMICAL ANALYSIS. PLEASE HELP WHEN CALLED UPON.**

1996 evaluation of Maryland tobacco grown following crimson clover utilizing the PSNT test to determine soil nitrogen fertility needs.

Section XVI

## TOBACCO PRODUCTION ECONOMICS

Once a year it is good to sit down and review the costs of producing a Maryland tobacco crop. Doing so allows individuals to make comparisons regarding the income potential of tobacco versus other crops. The Maryland Tobacco Improvement Foundation also receives numerous requests each year for costs of production information from individuals evaluating tobacco's profitability potential.

The review considers as many variable cash costs as possible. Fixed costs such as depreciation, interest, repairs, taxes, and insurance, are not included here because of the variability that exists between farm operations. When doing an individual appraisal, the grower should include the fixed costs associated with his or her specific operation.

To begin the review, Table A, Table B, and Table C, page 100 show selected 2002 Maryland tobacco production costs for one plantbed, one acre, and the total costs combined.

As with any labor intensive crop, labor costs need to be reviewed and included into any budget. In order to place a value on labor in tobacco, data used is from a study presented in Maryland Agricultural Experiment Station Publication 588-1966. This report was an allotment distribution and labor input study whereby 11 growers provided detailed information on the labor required during the various phases of producing the tobacco crop. Labor values used in this economic analysis are an average of all values reported.

Table D, page 101, presents cost data for labor associated with Maryland tobacco production when family labor supplies 0%, 25%, 50%, and 75% of the total labor force. Be sure to review the assumptions listed with Table D.

Table E, page 101, lists complete variable costs; those costs associated with one plantbed, one acre, and labor costs at each of the various family labor input levels.

Farmers selling tobacco incur various selling charges associated with selling their crop. Such charges include commission, a basket (warehouse) charge, the Maryland State tobacco Authority poundage tax, and possibly hauling. Table F, page 102, lists total charges for selling Maryland tobacco for yield levels between 900 and 2200 pounds per acre using the 2002 tobacco market season average price of $148.02 per cwt.

Now that variable costs and selling charges have been calculated, we can see the tobacco returns for each of the yield levels between 900 and 2200 pounds per acre at each of the various family labor input levels. Table G, page 102, presents this information.

Table A

Maryland Tobacco Production Costs For One Plantbed

| Input | Costs |
|---|---|
| Gas, Methyl bromide, 6 (1.5 pound cans) | $ 69.95 |
| Gas Sheet, 4 mil (12 x 100) | 24.00 |
| Cotton Cover (12 x 100) | 36.00 |
| Fertilizer, 50 lbs. 4-8-12 | 5.00 |
| Agri-strep (10 sprays) | 5.06 |
| Dithane DF (10 sprays) | 4.28 |
| Miscellaneous (trays, gasoline, etc.) | 15.00 |
| TOTAL | $ 159.29 |

Table B

Maryland Tobacco Production Costs For One Acre

| Input | Costs |
|---|---|
| Fuel, plow, disc, spray, plant – 10 gallons | $ 17.00 |
| Fertilizer, 500 lbs. per acre 8-8-24 | 71.25 |
| 333 lbs. per acre 15-0-14 | 56.10 |
| Lime, ½ ton | 9.50 |
| Prowl 3.3EC, 1.8 pints | 4.78 |
| Command 3 ME, 2 pints | 22.75 |
| Admire 2F, 6 ounces | 29.65 |
| Orthene 97P, .75 lb. mid-season | 11.95 |
| Orthene 97P, .75 lb. at topping | 11.95 |
| M-H, 1.5 pints per 1000 plants | 15.69 |
| Dithane DF (2 sprays), 1.2 lbs. | 3.42 |
| Acrobat MZ (2 sprays), 2.5 lbs. | 40.62 |
| Cultivation fuel, 2 passes | 3.40 |
| Sucker custom application | 25.00 |
| Cover crop | 15.00 |
| TOTAL | $ 338.04 |

Table C

Maryland Tobacco Production Costs for One Plant Bed and One Acre of Tobacco

| Item | Costs |
|---|---|
| Plantbed (See Table A) | $ 159.29 |
| One Acre (See Table B) | $ 338.04 |
| TOTAL | $ 497.33 |

Table D
Labor Costs Associated With Maryland Tobacco When
Family Labor Supplies 0%, 25%, 50%, and 75%
Of The Total Labor Force *

| | LABOR COSTS | | | |
|---|---|---|---|---|
| | - - - - - - Percent Family Labor Is - - - - - - | | | |
| Item | 0% | 25% | 50% | 75% |
| Plant | $ 300.00 | $ 225.00 | $150.00 | $ 75.00 |
| Top, Cut, Barn | 600.00 | 450.00 | 300.00 | 150.00 |
| Strip | 275.00 | 206.25 | 137.50 | 68.75 |
| Total | $ 1,175.00 | $ 881.25 | $587.50 | $ 293.75 |

*Assumptions (based on MP 588-1966)
100 man hours/acre take down, strip, grade, and pack
50 man hours/acre cut and house
25 man hours/acre plant
$12.00 hourly wage
$ .25 per stick stripping 1100 sticks per acre
50 hours of labor provided by owner (beds, plowing, cultivating, packing, selling, etc.)

Table E
Total Maryland Tobacco Production Costs for Plantbed
and One Acre With Associated Labor Costs, 2002

| VARIABLE COSTS | | | |
|---|---|---|---|
| - - - - - - Percent Family Labor Is - - - - - - | | | |
| 0% | 25% | 50% | 75% |
| $1,672.33 | $1,378.58 | $1,084.83 | $791.08 |

Table F
Total Charges For Selling Maryland Tobacco at Various Yield Levels for Season Average Price of $148.02/cwt., 2002 Growing Season *

| Yield | Charges | Yield | Charges |
|---|---|---|---|
| 900 lbs. | $ 75.25 | 1600 | $133.77 |
| 1000 lbs | $ 83.61 | 1700 | $142.14 |
| 1100 lbs. | $ 91.97 | 1800 | $150.50 |
| 1200 lbs. | $100.33 | 1900 | $158.86 |
| 1300 lbs. | $108.69 | 2000 | $167.22 |
| 1400 lbs. | $117.05 | 2100 | $175.58 |
| 1500 lbs. | $125.41 | 2200 | $183.94 |

* Fees
Warehouse commission: 4.50 percent (commissions may vary)
Basket (warehouse) charge: $1.50/cwt.
MSTA poundage tax: 0.20 cents/cwt.

Table G
Returns PER ACRE for Maryland Tobacco When Family Labor Supplied Is 0%, 25%, 50%, and 75% of the Total Labor Force and Tobacco Is Valued at $148.02 Per Cwt. *

| | | - - - - Returns When Family Labor Is - - - - | | | |
|---|---|---|---|---|---|
| Yield | Gross Less Warehouse | 0% | 25% | 50% | 75% |
| 900 | $1,257 | $ (415) | $ (122) | $ 172 | $ 466 |
| 1000 | $1,397 | $ (276) | $ 18 | $ 312 | $ 606 |
| 1100 | $1,536 | $ (136) | $ 158 | $ 451 | $ 745 |
| 1200 | $1,676 | $ 4 | $ 297 | $ 591 | $ 885 |
| 1300 | $1,816 | $ 143 | $ 437 | $ 731 | $1,024 |
| 1400 | $1,955 | $ 283 | $ 577 | $ 870 | $1,164 |
| 1500 | $2,235 | $ 423 | $ 716 | $1,010 | $1,304 |
| 1600 | $2,235 | $ 562 | $ 856 | $1,150 | $1,443 |
| 1700 | $2,374 | $ 702 | $ 996 | $1,289 | $1,583 |
| 1800 | $2,514 | $ 842 | $1,135 | $1,429 | $1,723 |
| 1900 | $2,654 | $ 981 | $1,275 | $1,569 | $1,862 |
| 2000 | $2,793 | $1,121 | $1,415 | $1,708 | $2,002 |
| 2100 | $2,933 | $1,261 | $1,554 | $1,848 | $2,142 |
| 2200 | $3,073 | $1,400 | $2,694 | $1,988 | $2,281 |

*Reduce each by this amount if operating loan is used for 10 months at the interest rate of 9.25%

$ 129 $ 106 $ 84 $ 61

Table H
Returns PER POUND for Maryland Tobacco When Family Labor Supplied is 0%, 25%, 50%, and 75% Of The Total Labor Force and Tobacco Is Valued at $148.02 Per Cwt.

| Yield | 0% | 25% | 50% | 75% |
|---|---|---|---|---|
| 900 | -0.46 | -0.14 | 0.19 | 0.52 |
| 1000 | -0.28 | 0.02 | 0.31 | 0.61 |
| 1100 | -0.12 | 0.14 | 0.41 | 0.68 |
| 1200 | 0.00 | 0.25 | 0.49 | 0.74 |
| 1300 | 0.11 | 0.34 | 0.56 | 0.79 |
| 1400 | 0.20 | 0.41 | 0.62 | 0.83 |
| 1500 | 0.28 | 0.48 | 0.67 | 0.87 |
| 1600 | 0.35 | 0.53 | 0.72 | 0.90 |
| 1700 | 0.41 | 0.59 | 0.76 | 0.93 |
| 1800 | 0.47 | 0.63 | 0.79 | 0.96 |
| 1900 | 0.52 | 0.67 | 0.83 | 0.98 |
| 2000 | 0.56 | 0.71 | 0.85 | 1.00 |
| 2100 | 0.60 | 0.74 | 0.88 | 1.02 |
| 2200 | 0.64 | 0.77 | 0.90 | 1.04 |

**TOBACCO GROWERS MUST ASSESS FOR THEMSELVES WHAT A FAIR RETURN SHOULD BE FOR THEIR INVESTMENT.** Returns expressed in Table G and Table H show a great deal of variability with the income earning potential of tobacco; particularly when given different labor and yield levels. It does point out the importance to strive for high yields and minimize production costs where possible.

One approach used for a profitability measure of the tobacco business can be found in Table I, page 104. The last row shows the poundage required to exceed the sum value for total variable costs plus returns from a certificate of deposit. You always have the option to invest variable cost funds at a bank instead of planting tobacco. As you can see, growers with 0% family labor input must produce in excess of 1156 pounds per acre to do this while growers with 75% family labor input must only produce in excess of 547 pounds per acre. When equating poundage and labor to profits, this could be a very reasonable approach.

It appears that money can be made in the tobacco business for some individuals given varying levels of production and labor inputs. After reviewing Table I, growers have something to make a comparison with regarding their present profitability level and where they want their profitability to be.

Table I
CD Return On Variable Cash Cost Dollars and Poundage
Required To Exceed Sum Value of Total Variable Cost
and CD Dollars When CD Is Earning 2.33%

| Family Labor As A Percent of Total Work Force | | | |
|---|---|---|---|
| 0% | 25% | 50% | 75% |
| | | | |
| Total Variable Cost | | | |
| $1,672.33 | $1,378.58 | $1,084.83 | $791.08 |
| | | | |
| 2.33% CD Return | | | |
| $38.97 | $32.12 | $25.28 | $18.43 |
| | | | |
| Total Variable Cost and CD | | | |
| $1,711.30 | $1,410.70 | $1,110.11 | $809.51 |
| | | | |
| Poundage To Exceed Sum Value of Total Variable Cost and CD | | | |
| 1156 lbs. or greater | 953 lbs. or greater | 750 lbs. or greater | 547 lbs. or greater |

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ADDRESS CORRECTION REQUESTED
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