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Float Greenhouse Tobacco: Transplant Production Guide

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Introduction

Commercial greenhouse production of tobacco transplants first appeared in Virginia in the mid-1980's. Initial adoption of this technology was slow due to the high cost of the structures and equipment. However, widespread acceptance of greenhouse tobacco transplant production has occurred in the 1990's. This has largely resulted from lower greenhouse costs, increased labor costs, and the generally good experiences of early greenhouse tobacco growers.

Transplant production costs are higher in a greenhouse compared to the best available management practices using outdoor plant beds. However, the three most often cited advantages of greenhouse production include:

- Labor savings: Greenhouse culture greatly reduces the amount of labor necessary for transplant production and eliminates the greatest labor peak before topping.
- Greater control of environmental conditions: Weather conditions have less direct impact on greenhouse culture than normally experienced in plant beds. Greenhouse- grown transplants tend to exhibit much less premature flowering than plant bed transplants.
- Uniform transplants: Greenhouse-grown transplants generally exhibit more uniform growth in the field than plant bed transplants. This may have positive benefits in cultivation and topping. Although the economic benefit of such uniformity is difficult to measure, the efficiency of cultivation and topping should be improved. However, extensive research indicates that there is no significant difference in either the yield or quality of tobacco from plant bed or greenhouse-grown transplants.

Other than the expense of greenhouse production, disadvantages of the system are less apparent but equally as significant as the above advantages, including:

- Increased capital investment in transplant production: The capital expenditure necessary for plant bed culture is minimal compared to greenhouse production. Additional uses for tobacco transplant greenhouses have been limited to date.
- New plant production system: The greenhouse production of transplants in a soilless growing media using hydroponic techniques requires attention to detail in new and different areas of plant production. Many critical production factors have not previously been a consideration in traditional plant bed culture.
- Limited pest control options: The potential for widespread, rapidly developing disease and insect outbreaks is always present and the number of pesticides labeled for greenhouse use is limited. Growers must rely on management practices to prevent pest problems from occurring.

A consequence of greenhouse transplant production that became evident in 1995 is the limited amount of excess tobacco transplants available. Historically, growers who experienced plant bed failure had neighbors with extra transplants. With the advent of greenhouse culture, excess transplants are generally presold or promised to other growers. If an unexpected loss of plants occurs in a community, transplants may be difficult to find. This places even greater importance on proper management to reduce the likelihood of serious plant production problems and to maximize the number of usable transplants.

Sanitation

Proper sanitation is critically important in preventing the introduction of diseases into a tobacco transplant greenhouse. Control measures after a pest outbreak

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occurs are limited and some loss of transplants will usually result. Therefore, preventative measures are generally the most effective control strategy. The four most important areas to consider in sanitation include:

- the area in and around the greenhouse
- people entering the greenhouse
- float trays
- clipping equipment and the clipping operation

The best management practice for the area surrounding the greenhouse is to provide adequate surface water drainage of the area. Surrounding the greenhouse with a border of sand, rock dust, or gravel will further aid in reducing surface moisture. Doing so will reduce damp conditions and prevent the introduction of soil into the greenhouse. Weed and grass growth should be controlled in the area immediately outside the greenhouse to eliminate potential habitat for insects (especially crickets and grasshoppers) that may move into the greenhouse and feed upon the tobacco seedlings. Sanitation within the greenhouse is made easier if concrete or gravel is used for walkways. Specific sanitation practices for the greenhouse structure itself, such as disinfecting the bay frames and metal bows, are probably not necessary since such objects will not support the development of disease organisms. If the greenhouse is emptied after the tobacco production season, any disease organisms present in the greenhouse should be killed by the high temperatures that occur during the summer (solarization).

Preventing the introduction of plant diseases spread by persons entering or working in the greenhouse deals primarily with tobacco mosaic virus and soilborne diseases that may be tracked in the greenhouse on shoes. Tobacco mosaic or TMV may be prevented by prohibiting the use of tobacco products (smoking or chewing) in the greenhouse. Smokers should wash hands with soap (phosphate soap, if possible) before entering. The use of a foot bath containing a 10 percent chlorine bleach solution and keeping the area immediately around the greenhouse entrance clean will reduce the likelihood of infested field soil contacting tobacco seedlings or media.

Float tray sanitation is of utmost importance in reducing the likelihood of introduction and spread of disease organisms within the greenhouse. Sanitation should begin for the next crop as the first crop is transplanted in the field. At the end of the day, or soon thereafter, trays should be washed to remove media, algae, and any field soil. The best option currently available to most growers is to fumigate with methyl bromide.

Directions for the use of methyl bromide fumigation are as follows:

- wash trays to remove surface debris
- arrange trays in loose stacks no higher than 5 ft. tall
- enclose the stacks in plastic (including the underside) and seal air tight with tape
- release 3 lbs. of methyl bromide per 1000 cu. ft. of enclosed space (approximately 1500 trays) and allow to set 24 to 48 hours
- carefully aerate trays before removing for use or placing into storage

Methyl bromide is a restricted use pesticide and must be used by a licensed pesticide applicator. Read and follow all label precautions.

An alternative to fumigation is the use of a dip solution. Trays may be dipped in either a chlorine bleach solution or a commercial greenhouse disinfectant product. Directions for disinfectant tray dips are as follows:

- dip trays in a 10 percent solution of chlorine bleach (1 gal. of bleach to 9 gal. of water)
- rinse trays in fresh water after dipping to remove excess residues that can be toxic to young tobacco seedlings under certain conditions
- If a commercial greenhouse sanitizing product is used, follow all label directions for proper dilution and use of the product. These products generally kill on contact with the pathogens. Rinsing of trays before seeding is a good practice to reduce the possibility of residues that may affect seedling growth. Bleach solutions kill pathogens on contact. Therefore, allowing the material to remain on trays does not increase the level of control and may actually injure young tobacco seedlings.

Research conducted in recent years has demonstrated that such dips are of limited effectiveness with the Styrofoam trays used in float greenhouse production. As trays are used from one season to the next, they become more porous and thus more difficult to effectively sanitize. Furthermore, injury due to excessive residues is also more likely to occur with each additional season of use.

Proper sanitation with the clipping of seedlings is important to prevent the spread or introduction of disease within the greenhouse. Clipping is a very effective

means of spreading tobacco mosaic virus (TMV); and therefore, the mower must be thoroughly cleaned to prevent spread of the virus throughout the entire greenhouse. Secondly, clippings that fall from the mower can serve as a food source for pathogens that may later infect tobacco seedlings.

Steps in clipping sanitation:

- remove all plant debris from the underside of the mower deck using soapy water. Either a brush or a high pressure washer may be used to clean the mowerdeck.
- the mower should be disinfested with a 50 percent bleach solution (1 gal. of bleach to 1 gal. of water) or other commercial greenhouse disinfectant product (follow label directions)
- cleaning the mower is easiest and most effective immediately after clipping rathe than before the next clipping
- use only a mower with a bagger attachment and empty the bag frequently to ensure clean removal of clippings
- if clumps of clippings fall onto plants -- periodically stop to remove excess debris from the underside of the mower deck

Ventilation and Air Circulation

Ventilation and air circulation are essential to providing environmental conditions most favorable for tobacco seedling growth. The typical greenhouse used for tobacco has side curtains that may be raised or lowered to provide natural ventilation. Such ventilation is important to prevent high temperatures and to remove moisture that naturally accumulates within the greenhouse.

Air circulation within the greenhouse is necessary to provide uniform distribution of temperature, humidity, and greenhouse gases. Horizontal air flow (HAF) is the most common means of circulating air within tobacco greenhouses. HAF fans are arranged in the greenhouse to provide a continuous movement of air throughout the entire greenhouse. Fans on one side of the house are oriented in one direction and those on the other side are directed in the opposite direction. Fans should be positioned every 50 feet and should not be directed downward toward the plants. A less common, yet equally effective, means of providing air circulation is the use of polytubes. These plastic tubes (approximately 15 in. diameter), with holes spaced at regular intervals throughout their length, are used to distribute air from a blower fan along the length of the greenhouse.

Either HAF or polytubes are effective in providing adequate air circulation within the greenhouse and should be considered a wise investment and an important greenhouse management tool. The circulation of air within the greenhouse reduces the likelihood of cold spots occurring and is important for disease control since moisture condensing on plant foliage is reduced.

Figure 1. Positioning of horizontal airflow fans (HAF) for air circulation within the greenhouse and the use of side curtains for ventillations

Condensation results from a difference in air temperature inside and outside the greenhouse. Warm air is capable of holding more water vapor than the cooler air outside the greenhouse. As the moisture ladden air inside the greenhouse is cooled upon contact with the plastic top, moisture condenses and droplets accumulate. Droplets falling onto trays may dislodge seeds or small seedlings, create a waterlogged area in trays, and wet the leaves of plants thus creating a condition favorable for disease. A certain amount of condensation is normal and unavoidable with the type of greenhouses used for tobacco transplant production. However, condensation is made worse by a lack of adequate ventilation. Exchanging fresh air for the humid air inside the greenhouse is very important at dusk as the outside temperature falls and at dawn as sunlight begins to heat the air within the greenhouse. Reducing condensation within the greenhouse is well worth the minimal amount of heat loss resulting from adequate ventilation. Louvered vents mounted high on the end walls can be used to provide needed ventilation without excessive loss of heat from the greenhouse. Such vents may be hand operated or automated with either a timer or thermostat.

Temperature Control

The first step in providing the most favorable temperature environment is knowing what the actual temperature is throughout the greenhouse. Thermometers should be placed at plant level to measure the actual temperature plants are exposed to. A thermometer that records maximum and minimum temperatures is especially useful to monitor the temperature when the greenhouse is unattended.

The most demanding period for temperature control is during seed germination. During the first 2 weeks, or until maximum germination, the temperature should be maintained at a minimum of 72 ° F. Cooler temperatures during germination will extend the number of days necessary to reach maximum germination and decrease uniformity in the size of seedlings. After germination, the minimum temperature may be reduced to 55 ° F.

Greenhouse tobacco seedlings appear to be more sensitive to the development of cold injury symptoms than plant bed seedlings, and certain varieties (i.e. Coker 371-Gold and NC 82) appear to be more susceptible than others. However, cold injury observed in greenhouses over the past few years has not appeared to permanently harm the seedlings or affect growth of the transplants.

Excessively high temperatures are of greater concern than low temperatures since mortality and subsequent loss of seedlings may occur. Particularly during the 2 to 4-leaf stage, the temperature at plant level should be kept below 95 ° F. Beyond the 4-leaf stage, mortality may not occur until 110 ° F. However, as temperatures rise above 95 ° F, additional stresses are placed on the seedlings due to increased water loss and the resulting concentration of fertilizer salts near the surface of the media.

Figure 2. Cold injury symptoms on float tobacco seedlings. Bud leaveswill appear yellow and early growth of leaves will be slightly distorted

The most effective means of controlling high temperatures in the greenhouse is the use of the side curtains for natural ventilation. This requires regular checks of the temperature in the greenhouse throughout the day and adjusting the side curtain accordingly. The use of automatic curtains and/or exhaust fans, controlled by thermostats, should be considered if someone is not available for daily management of greenhouse ventilation.

Media and Tray Filling

Media and the filling of float trays may be the area in which the greatest number of problems have occurred for Virginia growers. Tray filling has a direct impact on the number of seedlings that germinate and eventually grow to transplant size. The two most common problems are dry cells and spiral root plants.

Dry cells occur when media does not fill the entire cell depth. Thus, water fails to wick, the cell remains dry, and the seed does not germinate. Steps to reduce dry cells include:

- use media with the proper moisture content
- if necessary, screen media for sticks and other debris
- handle trays carefully after filling to avoid knocking media out of the bottom of the cells
- minimize unnecessary movement of trays in the float bay until cells have wicked

The use of premoistened media is highly recommended. A careful check of the media is suggested upon receipt. The addition of water to media should be avoided unless deemed absolutely necessary. As long as there is sufficient moisture to keep the media from falling through the bottom of the trays, it is generally best to use a drier mix rather than a mix with added moisture. Excessive moisture is related to seedling production problems that will be discussed later. If media is used that requires that water be added, bags should be opened the night before seeding and the appropriate amount of water added. Check for differences in moisture between individual bags. Non-uniformity in media moisture content and inadequate filling of trays with media may be the most significant cause of variation in germination, growth, fertilizer injury, and algae growth within tobacco transplant greenhouses. To quickly check for proper media moisture content, squeeze a

handful and observe whether particles crumble upon release. If the media crumbles, proper media moisture is confirmed. If particles fragment into individual particles or form a clod, the media is too dry or too wet, respectively.

Ideally, trays should be filled, seeded, and placed into float bays in continuous succession. Stacking filled trays to be floated later or transporting filled trays any significant distance will dislodge media from the underside of the trays and increase wicking problems. Bumping or dropping trays will further dislodge media. Tray filling and media problems may be reduced by filling and floating a few test trays to check for proper wicking before the entire greenhouse is seeded.

The cause of spiral root plants is not completely understood. However, it appears to be related to inadequate media aeration (too little air/too much water). Spiral root plants occur when the root of germinating seedlings does not penetrate into the growing media. Generally, a portion of these plants will survive and lag behind other plants, but most will die. Media must not be packed too tightly into trays or excessively moistened. If float trays are watered over-the-top to dissolve seed coatings, water should be applied as a fine mist. Large droplets can result in excessive packing and water logging of the media. However, the practice of overhead watering of the floats should generally be avoided unless to remedy other more serious problems.

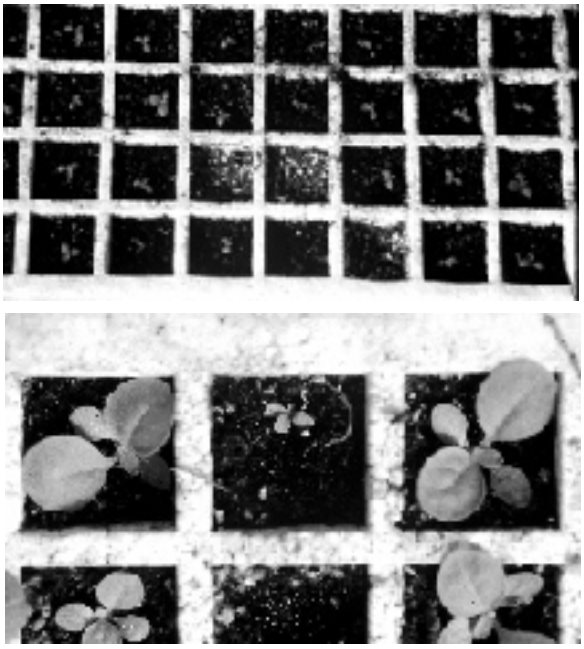

Figure 3. Two most common problems associated with filling of float trays. Dry cells (1) fail to properly wick water and seeds do not germinate. Spiral root plants (2) result from improper medium aeration caused by overpacking of trays or excessive watering over-the-top.

ay selection will influence both the productivity and management of a greenhouse. The outside dimensions of the different float trays used for tobacco production are the same, but differ in the number of cells or plants per tray. The advantage of trays with high cell numbers is the increased productivity of a given size greenhouse. For example, 44 percent more transplants could be grown using 288-cell trays instead of 200-cell trays. However, the level of management is greater with the higher density float trays. Both root volume and stem diameter decrease with increasing cell numbers. Grower experiences to date do not suggest that disease problems are any greater with any float cell number than another. Management is the most critical factor to producing high quality transplants.

Float trays commonly used for greenhouse tobacco production.

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

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

The biggest difference between the float cell numbers is the cost per transplant. The larger transplants from a 200-cell float cost more to produce since fewer can be grown per square foot of greenhouse. For most growers in Virginia, 288-cell floats would be a good compromise between stem size of the transplants and greenhouse management/transplant production costs.

Attention to the seeding of trays will result in a greater number of usable transplants. Unseeded or double-seeded cells will reduce the number of transplants. Proper dibbling of trays will provide better seed to media contact and position the seed in the center of the cells.

The date that a greenhouse is seeded has a significant impact upon the management of a greenhouse. Seeding too early increases heating costs, lengthens the exposure of plants to possible pest problems, and requires excessive clipping. Sixty to 65 days is a conservative estimate of the time needed to allow for growing plants from seeding to transplanting time. Management practices should be directed toward minimizing the number of days needed to grow seedlings to transplant size. These would include heating, fertilization, and clipping, in addition to the date that the greenhouse is seeded.

Fertilization

Fertilizers intended for greenhouse tobacco are formulated differently from fertilizers used on field tobacco or even water soluble fertilizers normally used on house plants. The growing media used in the greenhouse is a soilless mix and does not contain microorganisms normally present in field soil. These organisms are responsible for conversion of fertilizer elements from unavailable to plant-available forms. Greenhouse fertilizers must be formulated to provide nutrients in forms available to the plants. Most important, the nitrogen should be supplied from at least 50 percent nitrate sources and the balance from ammoniacal sources. The amount of nitrogen supplied from urea should be minimal. Use of fertilizers with high urea levels may result in seedling injury or death under certain environmental conditions.

Sulfur and magnesium are normally present in sufficient levels in growing mixes used for tobacco. If a sulfur deficiency occurs (young leaves appear yellow and plants grow slowly) Epsom salts may be added at a rate of 4 ounces per 100 gallons of water. Sulfur deficiency should not be mistaken for cold injury which may be common in tobacco greenhouses. Calcium needs are generally supplied from the water source. However, if water analyses indicate low levels or if deficiency symptoms occur, fertilizer materials supplying calcium and magnesium are available. Micronutrients are necessary in very small amounts and are generally supplied by the trace levels present in most fertilizers. Micronutrient levels should not be a major consideration in selecting a fertilizer for greenhouse tobacco. Boron deficiencies have been reported in the flue-cured tobacco production area in the Piedmont region of North Carolina. Such instances have not been widespread, but are usually associated with water sources containing virtually no boron (B) and plants that have been held at very low fertility levels for an extended period of time before transplanting. To date, no instances of boron deficiency have been reported in Virginia.

Greenhouse fertilizer rates are customarily expressed as "parts per million" (ppm) rather than pounds per acre or other more familiar units of measure. Parts per million may be defined as the quantity of a substance contained in a million parts of a solution. For example, a 100 ppm N solution contains 100 oz. of N per million ounces of water (weight to weight). Information to calculate the volume of water in float bays and the amount of fertilizer required to produce a solution of a specific concentration is detailed in an appendix in this publication.

Keys to Proper Greenhouse Fertilization

1. Use only appropriate fertilizer materials, considering:
   - nitrogen source
   - acid/base reaction of the fertilizer and the pH of the water
   - alkalinity level of water source
2. Supply correct fertilizer concentration based on fertilizer nutrient content (percent nitrogen) and the amount of water in float bays;
3. Mix fertilizer evenly throughout bay
4. Monitor fertilizer concentrations

Float Fertilization Programs

Three different fertilization programs are suggested for float greenhouse tobacco production, depending on management level.

Recommended Float Greenhouse Fertilization Programs.

		Program	
Fertizlizer Addition	**I***		**II**
		ppm N	
at seeding	150 or 100		0
2 weeks after seeding	--		150>
4 weeks after seeding or at 1st clipping	100 or 150		100

*In Program I, the total of both applications should be 250 ppm N. If 100 ppm N is added at seeding then 150 ppm N should be added at 4 weeks after seeding.

Under normal circumstances no additional fertilizer should be necessary beyond 250 ppm N. However, if the greenhouse is seeded too early and the production season is extended or if transplanting is delayed, a late season addition of fertilizer (75 to 100 ppm N) may be necessary to maintain adequate seedling nutrient levels.

Program I is the preferred fertilization schedule. This program provides a higher initial fertilization level at seeding. Research conducted at the Southern Piedmont AREC for two years and in grower greenhouses in 1995 and 1996 indicates that this fertilization schedule provides quicker growth of seedlings as compared to fertilization programs with little (50 ppm N) or no fertilizer provided at seeding. Seeding date could be delayed at least one week as compared to that required with Program II.

Program II provides seedlings with a reduced fertilizer level at seeding, thus decreasing the potential for fertilizer salt injury. However, such injury observed in Virginia is generally the result of errors in fertilizer addition, poor media quality, or improper fertilizer materials.

Program II is best suited for use with growing media that are described as "fortified" or containing a starter nutrient charge.

Comparative trials with fertilizer rates ranging from 0 to 250 ppm N indicate that algae growth will occur at any level of fertilization (50 ppm N and greater). When using an unfortified growing media, withholding fertilizer until one or two weeks after seeding will reduce algae growth at the expense of slower seedling growth.

Program III is to be used in greenhouses equipped with fertilizer injectors. Fertilizer injectors are used to add water containing a specified nutrient level to float bays. A concentrated fertilizer solution contained in a stock tank is diluted with the injector to obtain the desired nutrient level in the water to be added to the float bay. The suggested fertilization program using an injector is to add 125 ppm N to the bays each time water is needed (including the original filling). Actual nutrient levels present in the float bays should be monitored to insure that adequate fertility is maintained. Research conducted in six grower greenhouses in Virginia during 1995 indicates that nutrients may be taken up by the plants at a greater rate than water and that fertility levels reached very low levels in some instances.

Monitoring Nutrient Concentrations

Nutrient concentrations may be estimated by measuring the electrical conductivity resulting from dissolved ions (including fertilizer) in the water. Electrical conductivity is easily measured with inexpensive meters available from greenhouse and farm supply dealers. The DiST4TM meter has been the most commonly used meter in Virginia. Instructions and conversion charts for the DiST4TM meter are available from your local Extension agent. Assistance is also available for other conductivity meters that may be used.

Conductivity meters (ie. DiST4TM) do not actually measure nitrogen, but measure all dissolved ions in the nutrient solution. If both the fertilizer material and the base water conductivity are known, the nitrogen level of the fertilizer solution may be estimated.

Steps in Using the DiST4TM Meter

1. Calibrate the meter against a solution of known conductivity (DiST4TM units)
2. Make reading of the nutrient solution at several locations within the bay
3. Record DiST4TM value for unfertilized water source
4. Subtract water source reading (base) from nutrient solution values
5. Using the conversion chart for appropriate fertilizer source to determine the approximate nitrogen concentration (ppm)

One particularly useful purpose for the DiST4TM meter is to measure fertilizer concentration throughout a float bay. Areas of high and low concentrations may be identified and recirculation of the water may be needed to improve uniformity. Likewise, the uniformity in fertilizer concentration between bays may be determined.

Water Quality

Water is an important consideration with the greenhouse production of tobacco transplants. For the majority of growers in Virginia, the most important concern is having a sufficient quantity of water readily available. Generally, over the entire production season, one can plan on using approximately twice the volume of water needed to initially fill the bays.

The quality of the water is a critical factor to consider with greenhouse production. Although water sources across the flue-cured tobacco producing area of Vir-

ginia pose no difficulties for most growers, sporadic instances of water quality problems have occurred for some growers. The only means of predicting such problems is through water testing. It is important to have the water analyzed and the results interpreted for plant production properties rather than as drinking water.

The following steps will be helpful in sampling for water analysis:

- allow water to run to flush lines before collecting sample
- if a sample kit is not available, collect water in a 16 oz. plastic soft drink bottle (triple rinse with water to be sampled)
- fill bottle completely - leaving no air space
- Send sample to a laboratory for analysis. The names and addresses of laboratories that analyze water for greenhouse use is available from your greenhouse dealer or local Extension agent
- results of the analysis should be evaluated to determine whether treatment is necessary (high alkalinity or carbonates) and to choose the most appropriate fertilizer source (according to pH). Your local Extension agent is available to assist you in the interpretation of analysis results.

Municipal water supplies are generally suitable for greenhouse use. However, the chemical analysis of the water may change according to water treatment procedures. Avoid use immediately following the addition of calcium carbonate to the water. Furthermore, chlorine levels may fluctuate according to water treatment schedules.

Desirable range for selected water analysis determinations of transplant production.

Determination	Desirable range	units
pH	6.2 - 6.8	--
Soluble salts	0 - 75	mhos x 10-5/cm
Alkalinity* as $CaCO_3$	0 - 100	mg/l or ppm
Total carbonates* (TC)	0 - 2	meq
Sodium adsorption ratio (SAR)	0 - 4	--
Calcium (Ca)	20 - 100	ppm
Magnesium (Mg)	6 - 25	ppm

*Alkalinity and total carbonates are measures of the same water property and a laboratory will report only one value.

Surface water sources such as ponds and streams should be avoided for greenhouse production. The chemical properties of such waters are generally acceptable. However, soil-borne pathogens may wash from infested tobacco fields into these sources and inoculate the greenhouse with diseases.

The three most important water quality parameters for most growers are: pH, soluble salts (conductivity), and alkalinity or total carbonates. A low pH (5.0 to 6.0) indicates an acidic condition and a fertilizer that will raise the pH should be used. A high pH (greater than 7.5) will generally indicate high alkalinity levels (high carbonates). Acidifying fertilizers that lower the pH and neutralize alkalinity should be used. Remedies for high alkalinity will depend on the severity:

	Total	
Alkalinity	Carbonates	Corrective Action
(ppm or mg/l)	(meq)	
100- 200	2 - 4	neutralize with fertilizer selection (Peters Excel 15-5-15)
200 +	4 +	neutralize with addition of acid

Clipping

Clipping is an essential management practice for direct-seeded greenhouse tobacco production. The benefits of clipping include:

1. Increased seedling uniformity
2. Removal of excess foliage thus allowing the plant canopy to more effectively dry.
3. Regulation of seedling growth. Begin clipping when seedlings are 2 to 2.5 inches tall, measuring to the smallest visible bud leaves. Several clipping studies conducted in Virginia indicate that the timing of the first clipping, the severity of clipping, and the total number of clippings do not have a significant impact on the stem diameter of the transplants. However, the above factors were important in controlling the growth rate of the seedlings and the eventual size of the transplants. Very early clipping (1.5 inches to bud or less) resulted in shorter than desirable transplants.

The impact of excessive clipping was also apparent as reduced growth in the field which was present through topping time.

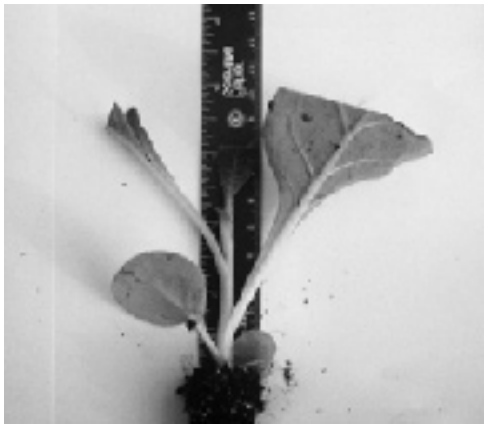

Figure 4. An example of a properly clipped tobacco seedling following first clipping. The seedling should be 2 to 2.5 inches tall to the smallest bud leaves and the blade should be no closer than 1 inch above the bud.

Suggested Clipping Program

- Begin clipping when plants are 2 to 2.5 inches tall (bud height)
- Set mower blade 1 1o 1.5 inches above bud
- Clip on a 3-day interval between the first 3 clippings and every 5 days thereafter

Sanitation is a critical aspect of clipping. Plant clippings must be collected to reduce the likelihood of disease development and spread throughout the entire greenhouse. Empty the collection bag frequently to prevent clipping materials from falling onto seedlings and clean under the mower deck if clippings are not completely removed. The mower used to clip plants should be thoroughly cleaned and sanitized following each use(50% chlorine bleach solution).

Figure 5. Poor clipping sanitation can result in disease outbreaks by providing an initial food source for organisms to become established.

Storm Preparedness

Winter storms during the past two years have demonstrated the vulnerability of tobacco transplant greenhouses to severe storms. High winds in 1993 resulted in serious damage to a number of greenhouses in North Carolina. Such damage can be reduced by providing proper foundation anchoring and minimizing the wind resistance of the plastic top. Side wall posts should be anchored into concrete. Properly anchoring the greenhouse foundation more effectively reduces wind damage than horizontal bracing within the greenhouse. Such bracing is more important for structural strength against the weight of snow loading.

Loss of inflation in the double layer plastic top increases the wind resistance and thereby increases the likelihood that the top will be damaged. For this reason, growers should consider having a backup power generator available in the event that electricity is lost. The electrical demands of the inflation fans and heaters are minimal and can be met with generators commonly used on the farm for other purposes.

Damage due to ice and/or snow occurs when the weight of the accumulation on the plastic top exceeds the structural strength of the greenhouse. Therefore, damage can be reduced by limiting the amount of snow or ice allowed to accumulate on the greenhouse top. Accumulation of ice and snow is most effectively prevented by heating the greenhouse to melt any ice or snow and by removing by hand any accumulation that may occur. Growers should prepare for winter weather by having gas tanks filled and heaters operational before a storm is expected. Back-up generators will insure an uninterrupted supply of electricity to operate inflation fans and heaters and prevent structural damage to the greenhouse.

Algae in Tobacco Greenhouses

The growth of algae on trays and media is often a big concern in tobacco transplant greenhouses. However, actual harm to the seedlings is quite unusual. Algae tends to be most severe and to cause the greatest concern when growing conditions are least favorable for seedling growth. Heating the greenhouse to encourage rapid, early growth of seedlings and minimizing surface moisture (ventilation and air circulation) will reduce the severity of algae growth.

Research conducted with different fertilization rates has not shown any significant differences in algae growth when nitrogen levels are reduced from 150 to 50 ppm

at seeding. Delaying the addition of any fertilizer one to two weeks after seeding will reduce algae growth at the expense of slowed seedling growth. Algae growth will be worse on used trays; thus proper washing and sanitizing is important to remove algae from the previous crop. Commercial products to prevent algae (algaecides) in the greenhouse are not recommended due to their general lack of effectiveness and difficulties in proper application.

Appendix

Calculation of Water Volume and Fertilizer Concentration

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

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

example: $50 \text{ ft.} \times 16 \text{ ft} \times \frac{4 \text{ in}}{12} \times 7.48 = 1994 \text{ gal}$

the amount of fertilizer required per 100 gal. of water is calculaed by:

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

example: $\frac{150 \text{ ppmN}}{20\%\text{N}} \times 1.33 = 10\text{oz. per 100 gal}$

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

	ounces of fertilizer per 100 gals of water at various nitrogen(N) concentrations (ppm)					
Fertilizer analysis	**50**	**75**	**100**	**125**	**150**	**200**
21-5-20	3.2	4.8	6.3	7.9	9.5	12.7
20-10-20						
or						
20-9-20	3.3	5.0	6.7	8.3	10.0	13.3
17-5-24	3.9	5.9	7.8	9.8	11.7	15.6
17-5-24	2.6	3.9	5.2	6.6	7.8	10.5
and	and	and	and	and	and	and
15-0-15A	1.5	2.2	2.9	3.7	4.4	5.9
16-4-16						
or						
16-5-16	4.2	6.2	8.3	10.4	12.5	16.6
15-5-15						
or						
5-4-15	4.3	6.7	8.9	11.1	13.3	17.7

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