Management of Tobacco Float Systems

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What is the value of a tobacco transplant? The typical market value of finished transplants is in the range of $38–$45 per one thousand plants. However the true value of a quality transplant lies in its potential to produce a high yield at the end of the growing season. Poor field management can result in low yields from good quality transplants, but good field management cannot always rescue poor quality transplants.

Most tobacco growers have the knowledge and skills necessary to grow good quality transplants, but many do not have the time to do the job right. For some the best decision may be to purchase transplants and allow someone else to absorb the risks of transplant production. Growers who derive a significant portion of their farm income from transplant sales tend to spend more time managing their float facilities than growers who grow transplants only for their own use. This does not mean that purchased plants are always better quality than you can grow yourself. Transplant buyers should consider carefully the reputation of the transplant producer, ask questions about their management practices, and carefully inspect transplants upon delivery.

There are risks associated with transporting transplants over long distances. Transplants may be infected with a disease even though they appear healthy at the time of delivery. One example of this principle is with the potential for blue mold on transplants grown in the Deep South. Blue mold does not overwinter in Kentucky, and is typically spread into our area on wind currents from southwestern source areas. When infected transplants are brought in, blue mold "hot spots" can develop rapidly and greatly accelerate the problem, costing growers money in lost production and increased control measures. If you choose to purchase transplants consider working with a local producer to minimize the risk of introducing disease and to help stimulate the local farm economy, or buy plants produced in areas north of Kentucky (where blue mold is unlikely to be present).

For growers who choose to produce their own transplants there are three general systems to consider: 1) Plug and transfer in unheated outdoor float beds, 2) Direct seeding in unheated outdoor float beds, and 3) Direct seeding in heated greenhouses. Each of these systems has its advantages and disadvantages, but all can be used to produce quality transplants. Table 1 shows a relative comparison of these three systems. Some growers may utilize more than one system; for example seeding in a heated greenhouse and moving plants to an unheated bed after germination.

Table 1. Relative advantages and disadvantages of tobacco float systems.

Characteristic	Plug and Transfer	Direct Seed: Outside	Direct Seed: Greenhouse
Labor requirement	High	Medium	Low
Cost per plant	Medium	Low	High
Target usable plants (%)	95	80	90
Management intensity	Medium	High	High
Risk of plant loss	Medium	High	Medium
Risk of introduced disease	High	Low	Low
Uniformity of plants	High	Low	Medium
Degree of grower control	Medium	Low	High
Time to usable plants (weeks)	3 to 4*	8 to 10	7 to 9

** Weeks after plugging*

Tray Selection

Most trays used in tobacco float systems are made of polystyrene and manufacturers control the density of the tray by the amount of material injected into the mold. Higher density trays tend to be more durable and have a longer useful life than low density trays, but they also tend to be more expensive. In some cases an inexpensive low density tray may be desired for those who sell finished plants and have difficulty getting trays returned, or are concerned about potential disease problems with returned trays. Some problems have been reported with roots growing into the walls of low density trays, making it difficult to remove the plants.

Some trays have been described as "glazed"; these have been manufactured by a process that seals the inner surfaces of the cells. Data from greenhouse trials with new trays have shown little difference in transplant production in glazed or unglazed trays (Table 2), although glazed trays may be slightly easier to clean and sanitize due to the sealed surface in contact with the plant roots.

Yet another choice in tray design appeared on the market in 2006. A "shallow" tray has the same length and width as a regular tray but is only 1.5 inches deep as compared to the 2.5 inch depth of a regular tray. In limited testing the shallow trays had fewer dry cells, slightly lower germination, and slightly more spiral roots than regular trays (Table 2). In the end there was no difference in the production of usable transplants. The field performance of plants produced in shallow trays has not been systematically tested so we do not know if the smaller root volume will have adverse effects on the establishment and growth of the transplants. The advantages of the shallow trays are reduced amount of soil-less media needed and reduced space needed for tray storage.

Table 2. Greenhouse performance of float trays.

Tray type	Dry Cells (%)	Germination (%)	Spiral Root (%)	Usable Plants (%)
2004 data				
Regular	--	96.0	6.1	89.8
"Glazed"	--	96.5	6.1	91.0
LSD 0.05*		NS	NS	1.1
2006 data				
Regular	0.8	97.4	1.9	91.4
Shallow	0.1	96.7	2.8	91.0
LSD 0.05*	0.3	0.5	0.6	NS

** Small differences between treatments that are less than this are not considered to be real differences due to the treatment, but are thought to be due to random error and normal variability in plant growth.*

The choice of cell number per tray comes down to maximizing the number of plants produced per unit area, while still producing healthy plants of sufficient size for easy handling. The outside dimensions of most float trays are approximately the same, so as the number of cells increases, the cell volume generally decreases. However, the depth of the tray and cell design can influence cell volume. In general, as the cell volume decreases, so does the optimum finished plant size. Smaller plants are not a problem for growers using carousel setters, but those with finger-type setters may have difficulty setting smaller plants deep enough. There are some slight variations in tray dimensions from one manufacturer to another. Be sure that the tray selected matches the dibble board and seeder to be used.

Some float plant producers try to maximize plant production per unit area as a means of lowering overhead production costs. High cell number trays (338 and higher) have been used successfully to do this by some greenhouse operators, but more time and a greater level of management are needed to grow transplants at these higher densities. Disease management is also more difficult with high cell numbers, requiring better environmental control, more frequent clipping, and diligent spray programs. For most tobacco producers with limited greenhouse experience, a 242 or 288 cell tray is a good compromise.

Trays with lower cell numbers are recommended for transplant production in outside beds. The lack of environmental control and infrequent clipping of outside beds makes the use of high density trays a risky venture. Since the cost of outdoor bed space is relatively inexpensive compared to a greenhouse, there is not as much pressure to produce the maximum number of plants per square foot.

Tray Sanitation and Care

A good sanitation program is critical for consistent success in the float system. For many of the diseases that are a problem in float plants, sanitation is the first line of defense. Sanitation of trays is difficult because of the porous nature of polystyrene. As the trays age they become more porous, and with each successive use, more roots grow into the tray. This allows pathogenic organisms to become embedded deep in the tray where they are difficult to reach with sanitizing agents.

Trays should be rinsed off immediately after transplanting to remove any media, plant debris or field soil. Some of the organisms that cause diseases in the float system are common soil inhabitants, and field pathogens. So, after trays have been used to grow a crop of transplants and been to the field for transplanting, they may be contaminated.

Trays may be disinfected prior to storage or just before seeding in the spring. They should be stored indoors out of direct sunlight. Do not store trays in a greenhouse where UV light and heat will cause deterioration and damage. If trays have been sanitized prior to storage, store them in such a way as to avoid recontamination. Take appropriate steps to protect trays from damage due to the nesting activity of small rodents and birds.

Disinfectants available are: Steam, chlorinebleach, and quaternary ammonium chloride salts. None of these have been totally effective in killing all the pathogens. Each has positive and negative points, as discussed below.

In our studies, steam has been the most effective disinfectant. It consistently does the best job of killing the range of pathogens found in Kentucky. Steam sterilization of trays is especially recommended for commercial transplant producers. Steaming at 170-180°F for 30 minutes has been successful, but lower temperatures and longer times may also be used. The cost of using steam to sterilize trays, however, is high and some trays will be damaged by steaming. Thus, the biggest problem with steaming at the farm level is insufficient control steam to reach and maintain the recommended temperature range for the prescribed period of time without damaging the trays.

Chlorine bleach solutions have given a high level of control, but, overall, are not as effective as steam. We have found little benefit of using more than 1 part bleach to 9 parts water (10% solution). Any commercially available bleach can be used to make the sterilizing solution, but avoid concentrated formulations. Industrial-type bleaches cost more and don't add any additional benefit, as mentioned above. Bleaches work best when the trays are washed with soapy water, dipped several times into clean 10% solution, and covered with a tarp to keep them wet overnight with the bleaching solution. Afterwards, the bleach solution should be washed from the trays with clean water or water plus a quaternary ammonium chloride salts, as listed below, followed by aeration to eliminate the chlorine and salts of chlorine. Without proper aeration and postwashes, salt residues can cause serious problems, especially with older trays that tend to soak up more materials. Worker safety issues are also important with bleach. It is critical that the bleach solution remain below pH 6.8 and that a new solution be made up every 2 hrs, or whenever it becomes dirty, whichever comes first. Organic matter deactivates bleach quickly.

Quaternary ammonium chloride salts are marketed under such trade names as Greenshield, Physan, and Prevent as solutions containing 20% ammonium chloride. While many growers use them, our tests indicate that they are not as effective as some believe. Their greatest benefit is in the final wash and on exposed surfaces in the greenhouse. In all our tests, they have always provided some control, as compared to using soap washes only, but have always been inferior to any of the above mentioned methods.

Water Quality

Water quality for tobacco float plants has not been a big problem in Kentucky when using a fertilizer that is well suited for the float system. However, there are a few things to keep in mind. Never use untreated surface water for tobacco float beds. Surface water may contain high levels of disease-causing organisms. Water from most municipal and county water systems has been found to be suitable for use in the float system. In a few water districts, the alkalinity levels have been found to be above acceptable levels.

Water from private wells occasionally has higher than desired levels of alkalinity, with about 15-20% of the wells tested requiring the addition of acid to reduce the alkalinity to a manageable range for float plant production. Rarely are there cases where water quality problems are severe enough to warrant switching to a different water source. A preliminary check of water quality can be made with a conductivity meter and swimming pool test strips that measure pH and alkalinity. Conductivity readings above 1.2 microsiemens/centimeter (µs/cm) or alkalinity above 180 ppm suggest the need for a complete water analysis. For more information on water quality for float beds see AGR-164, *Water Quality Guidelines for Tobacco Float Systems.*

Media Selection and Tray Filling and Seeding

The three basic components of soil-less media used in the float system are peat moss, perlite, and vermiculite. Peat is the brown material that is used in all the media to provide water and nutrient holding capacity. Vermiculite is the shiny, flaky material, and perlite is the white material used in some media. Different brands of media have varying amounts of these components. Some have only peat and vermiculite, others have only peat and perlite, and still others have all three ingredients. Research to date has not indicated any particular combination of ingredients or brand of media to be consistently superior to the others (Table 3). Year to year variability within the same brand of media can be quite high, so there is a need to continually check and adjust tray filling and seeding procedures each year.

Careful attention to tray filling procedures will minimize the occurrence of dry cells and spiral roots. Dry cells occur when the media bridges and does not reach the bottom of the tray, or when a portion of the media sifts out the bottom of the tray. When this happens water does not wick and the seed in that cell will not germinate. A few dry cells (1% or less) should be considered normal. It is a good idea to check a few trays during tray filling to make sure that a plug of media is in the small hole at the bottom of the tray. If bridging of media is a consistent problem try pouring it through a coarse mesh screen to remove stick and clumps. If media is falling out the bottom of trays you may need to add one or two quarts of water to each bag of media prior to tray filling. Wait 24 hours, if possible, to allow time for moisture to adjust evenly.

Each year there are a few cases where large groups of trays fail to wick up after a reasonable period of time. Many of these cases have been traced back to the use of media left over from the previous year. During storage the media dries out and the wetting agents tend to break down over time causing the media to be difficult to rewet. The use of left over media should be avoided if possible, however if it is known that the media is old, try adding two or three quarts of water per bag at least a day before seeding. It is also a good idea to record the lot numbers (if legible) off any bags of media used as they can be very helpful in tracking down the source of problems.

Table 3. Production of usable burley tobacco transplants in selected soilless media in a tobacco float system.

	Usable Plants (%)		
Brand of Media	**2006**	**2005**	**2004**
Beltwide All Peat	89.9	90.1	--
Burley Gold	88.2	90.5	95.1
Carolina Choice	93.3	90.8	90.1
Carolina Silver	92.6	91.5	90.7
Kentucky Paydirt	90.4	92.3	--
Metromix Ag-lite	94.2	88.1	--
Southern States	92.4	92.2	88.0
Southern States w coir	88.1	--	91.2
Speedling fortified	90.8	88.5	91.4
Sunshine LT-5	92.0	91.3	90.7
LSD 0.05*	2.2	2.6	2.0

** Small differences between treatments that are less than this are not considered to be real differences due to the treatment, but are thought to be due to random error and normal variability in plant growth.*

Spiral root is a term used to describe a germinating float plant in which the emerging root does not grow down into the media, but instead grows on the surface often looping around the plant (Figure 1). It is thought to be the result of physical damage to the root tip as the root attempts to break out of the seed and pellet. Whether or not a particular plant will have spiral root is determined by a complex interaction between the variety, the seed/pellet, media properties, and weather conditions. Table 4 shows the influence variety and seed source on spiral root occurrence in dark tobacco. Similar results have been observed in burley tobacco with the variety KY14 x L8 having a higher incidence of spiral root than other varieties.

Figure 1. Spiral root of a burley tobacco transplant.

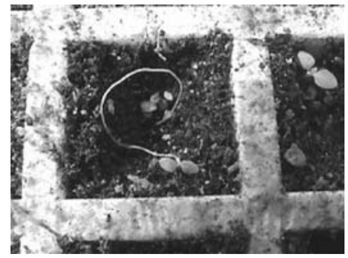

Table 4. Effect of seed source and variety on spiral rooting at 21 days after seeding.

	Seed Source			**Seed Source**
	Rickard	*Workman*	*Newton*	
Variety	**% Spiral Rooting**			**LSD 0.05**
Narrowleaf Madole	11.2	5.4	4.9	3.1
KY 171	1.0	1.4	2.0	0.9
KT D4LC	4.3	4.4	2.6	3.4
LSD 0.05 (variety)	2.0	2.9	2.9	

The incidence of spiral root has decreased during the last two growing seasons, due in part to changes made to the pellets by some tobacco seed companies. Nevertheless, spiral root can still be a problem that results in a significant reduction in usable plants. To minimize spiral rooting avoid packing media tightly into the trays. Trays should be allowed to fill by gravity without additional pressure applied to the top of the tray.

After the trays are filled a small indentation or "dibble" should be made in the surface of the media. Research has shown that seed germination is much more consistent in dibbled trays than in non-dibbled trays. The dibble board or rolling dibbler should be matched to the brand of tray such that the dibble mark is as close as possible to the center of each cell. The dibble should be ½–¾ inches deep, with relatively smooth sides to allow the seed to roll to the bottom of the dibble. Handle the trays with care after dibbling to avoid collapsing the dibble prior to seeding.

Like the dibbler, the seeder should be matched to the brand of tray that you have. There are slight differences in the dimensions of trays from different manufacturers. If the seeder is not matched to the tray, seeds may be placed near the edge of the cell where they are less likely to germinate. After seeding, examine the trays to ensure that there is only one seed in each cell. The seed should be near the center of the cell, and at the bottom of the dibble. Seeds that fall outside of the dibble or on the side of the dibble mark are more likely to experience problems with germination or spiral root.

If spiral roots are consistently a problem, a light covering of media over the seed may be considered. A light dusting is all that is needed; the tops of the seed should remain visible. Research by Danny Peek in Virginia has suggested that in many cases all that is needed is just a bump on the tray after seeding to settle the seed and gently collapse the dibble around the seed. Often growers who seed at one location and then move trays by wagon or truck to the greenhouse report fewer problems with spiral root, due most likely to the shaking of the tray while transporting.

Primed Seed

Seed priming is a process in which seeds are pre-germinated under controlled conditions before being dried back down and pelleted. The desired effect of using primed seed is to reduce time to germination and improve uniformity. Research has shown that primed seed germinate about 2 days earlier than unprimed seed sown at the same time. In the controlled environment of a greenhouse the final germination at 14 days is not usually different between primed and unprimed seed. In outside float beds primed seed may be advantageous because they tend to germinate more uniformly than unprimed seeds at cooler temperatures.

Fertilizer Selection and Use

Choose a fertilizer that is suitable for use in the float system. Many water soluble fertilizers sold at garden shops do not contain the proper balance of nutrients in the right form for tobacco transplants. Specifically, avoid fertilizers which have a high proportion of nitrogen in the form of urea. Look for a fertilizer with mostly nitrate nitrogen and little or no urea. In the float system urea is converted to nitrite which is toxic to plants. Information about the nitrogen source should be on the product label. If it is not there, don't buy that product for the float system.

Research has shown that tobacco transplants do not need a high level of phosphate. Some research even suggests that there is a better balance of top and root growth if phosphate levels are kept lower. Look for a fertilizer with low phosphate like 20-10-20, 15-5-15, 20-5-20, 16-4-16, etc.

Fertilizer can be added to float water just at seeding or within 7–10 days after seeding. The advantage of fertilizing at seeding is convenience in that the fertilizer can be dissolved in a bucket, poured in to the bed and mixed easily. The disadvantage is that salts can build up at the media surface during hot, sunny conditions. As built up water evaporates from the media surface the fertilizer salts can be wicked up and deposited where they may cause damage to the germinating seed.

Delaying the addition of fertilizer until a few days after seeding minimizes the risk of salts damage to young seedlings. Many producers have built simple distribution systems with PVC pipe or hoses to help mix fertilizers and chemicals throughout large float beds without having to remove trays. The distribution systems are typically connected to small submersible pumps that can be lowered into a bucket of dissolved fertilizer. The addition of fertilizer should not be delayed by more than 7–10 day after seeding, or a lag in plant growth may result.

Over-fertilization of float plants is a common mistake. The recommended level of fertilization is no more than 100 parts per million nitrogen. This is equivalent to 4.2 lb of 20-10-20 per 1000 gal of water. To determine the gallons of water in a float bed use the following formula:

  Number of trays the bed holds
x depth of water in inches
x 1.64
= gallons of water.

When transplants are not developing fast enough, some growers are tempted to add more fertilizer to push the plants along. At high rates of fertilizer, plant growth will be very lush, making the plants susceptible to bacterial soft rots, Pythium root rot, and collar rot. Under-fertilized plants grow more slowly and are more susceptible to such diseases as target spot.

The incidence of improper fertilization can be reduced by investing in a conductivity meter and monitoring the salt concentration on a regular basis. A conductivity meter measures how easy it is to pass a current through a solution. The higher the salt content of the solution the greater the current. Conductivity meters need to be calibrated periodically to insure proper operation. Check the instructions that came with the meter or visit your local County Extension Office for help calibrating. To use the meter, measure the reading of your water source prior to fertilization. Most water sources have a conductivity of between 0.1 and 0.5 µs/cm before fertilization. However, salt levels above 0.9 µs/cm may become too salty for optimum plant growth after fertilizing. Older meters may read in 100 µS/cm and therefore would read between 1.0 and 5.0 100 µS/cm. Meters that read in ppm dissolved solids are discouraged due to difficulty in determining the corresponding increase expected after fertilizing.

After testing the water, calculate the amount of fertilizer needed for the bed. Add the fertilizer to the bed and mix thoroughly before reading again. The reading should go up by 0.5 to 0.9 units, depending on the type of fertilizer used. For the most commonly used 20-10-20 formulations, the reading increases by 0.3 units for every 50 ppm N added. The reading obtained after fertilization should be the target level. If the reading falls below the target, add more fertilizer. If it is above the target add water to dilute the fertilizer and avoid problems with over-fertilization. Many water soluble fertilizers now have charts on the label to help you interpret conductivity readings.

Climate Control

Temperature Management

Pelleted seeds germinate best around 70–75°F. However, a fluctuation from cool night temperatures and warm daytime temperatures may be beneficial for optimum plant growth. While cooler temperatures tend to slow germination and growth, higher temperatures are risky. Temperatures that exceed 90°F may prevent germination and predispose plants to cold damage. Primed seed which tend to germinate quicker than regular pelleted seed may also tend to tolerate cooler temperatures better. A good rule of thumb is that if it's too hot to work in a greenhouse it's too hot for the plants. Temperature in excess of 100°F may be unavoidable on hot, sunny days, but every attempt should be made to manage the ventilation to reduce the length of time that plants are exposed to excessive heat. Plants exposed to excessive high temperatures may suffer more damage during cool nights or when exposed to outside air when greenhouses and float beds are ventilated during the day.

Cold damage can result when plants that have been exposed to high temperature are then exposed to cold air. Symptoms of cold damage are usually visible within two or three days and include an upward cupping of the leaf tips, constricted regions of the leaves, and a distinct yellowing of the bud. Once the bud has been damaged it no longer can suppress the development of suckers. While the bud usually recovers from this damage and re-establishes control over the suckers, the sucker buds have already been initiated. They may begin to grow again if the plant is subjected to further stress. That stress often occurs after transplanting when the sucker buds begin to develop into ground suckers. Maintaining an even temperature that doesn't fluctuate too drastically can help reduce ground sucker problems. In severe cases plants may produce ground suckers that are not suppressed and that grow into multiple stalks from a single plant. Such plants will be difficult to harvest and produce low yield and poor quality tobacco.

Accurate measurement is important for good control of temperature. Thermostats and thermometers exposed to direct sunlight will give false readings. Both devices should be shielded for accurate readings. Thermostats should not be located too close to doors and end walls or positioned too high above plant level. The most accurate results are obtained from shielded thermostats with forced air movement across the sensors.

Fans for ventilation are rated in CFM's or cubic feet per minute. Typically a greenhouse used for tobacco float plant production in Kentucky should have enough fan power to exchange ¾ –1 times the volume of air in a greenhouse per minute. Two fans allow for the fans to be staged so that the first comes on at a lower temperature than the second. Fans with more than one speed are more expensive, but allow the speed to increase as the air temperature inside the greenhouse increases.

Shutters are designed to complement fans and should be located at the opposite end of the greenhouse and should have an opening equal to or 1¼–1½ times the size of the fan. Motorized type shutters are best and should be on a thermostat set at a 2-3 degree cooler setting than the fans so that they open prior to the fans. Alternatively, fans may be set on an 8–10 sec delay which will accomplish the same thing. To reduce cold injury damage locate fans and shutters 3 feet above plant levels to minimize drafts and to improve mixing of cooler air with the warmer air inside the greenhouse. Baffles can be used inside to deflect cool, incoming air upward and away from the plants.

Side curtains are dependent on natural air movement for good ventilation. Although they are cheaper to install and operate than fans they do present some risk. A cool, rainy morning may rapidly change to a sunny day. If no one is available to make sure curtains are lowered plant damage can occur within minutes after the sun comes out. It is important to have someone at or near the greenhouse to lower curtains when needed. Automated curtains are an option, but may offer less precise operation than fans. Many greenhouses in Kentucky have both fans and curtains which offer the most control of the growing environment. A side curtain should, at its maximum, provide one foot of vertical opening per 10 ft of greenhouse width. A typical 36 ft wide greenhouse may have only a 3 foot side curtain that will drop 2 feet, but may have 1 foot of plastic hanging down over the side providing only 1 foot of effective ventilation. A best system would have a 5 foot side wall that could be open to 3½–4 feet to meet the required guideline for ventilation.

For more information please see ID-131, *Basics for Heating and Cooling Greenhouses for Tobacco Transplant Production.*

Humidity Management

Humidity can cause numerous problems inside a greenhouse or float system. As the warm moist air comes in contact with cool surfaces such as greenhouse plastic, support pipes and float bed covers, it condenses as droplets that can dislodge and fall to the trays disturbing seeds and seedlings, and can knock soil out of cells resulting in stand loss. Some foliar diseases may be favored by high humidity. High humidity can also reduce the longevity of some metal components such as heaters and supports by promoting the development of rust. In greenhouses, the best control of condensation and moisture is through the proper control of ventilation and heating.

Excessive humidity is more common in greenhouses than in outdoor float beds due to more ventilation in outdoor beds. Sources of humidity include evaporation from the float beds, transpiration as water moves through a plant's system and into the air, and the release of moisture during the combustion of natural or LP gas. Non-vented heaters will generate more humidity than vented heater because all of the heat, fumes and water vapor are released into the greenhouse. Ventilation is essential for greenhouses with non-vented heating systems, but is also a good idea for vented systems.

While ventilation seems counterproductive to keeping a greenhouse heated, ventilation replaces some of the warm moist air with cooler, less humid air. Warm air can hold a lot more moisture than cooler air, a concept that can aid in regulating humidity.

Regulation of humidity can begin as the sun goes down in the evening. Turning a fan on manually pushes warm humid air out replacing it with cooler less humid air. The exchange of air can reduce problems that tend to escalate during the cooler part of the day. This process will take only a few minutes of fan time to complete. However, producers are reluctant to use this method due to the cost of reheating the cooler air. The benefits can outweigh the cost during cooler weather periods by reducing the damage caused by condensation collecting and falling from the inner surface of the greenhouse onto trays.

An exchange of air at day break can be used in combination with the exchange at night. Ventilation at this time is almost essential. Fans are safer than side curtains due to possible cold injury from side curtains. Fans should be switched on manually for a few minutes. If only one of two fans is used for this procedure then more time may be needed. As cooler air enters the greenhouse and comes in contact with the warm moist air, fog may form, but should dissipate quickly. Once the humid air has been exchanged, the fans should be switched off and set to come on automatically when the air temperature reaches a set point. Later in the day when outside temperatures rise, side curtains, if available, can be lowered to improve ventilation.

Other methods may be used to protect plants from the damage caused by dripping, but they do little to control the cause of condensation, or reduce disease potential. Building the greenhouse or bed with a steeper pitch will reduce problems because the condensation that forms will have a greater tendency to roll off the sides rather than drip. Some growers use bed covers at the plant level to protect plant from dripping. With this method three common problems occur: (1) the plants get too hot, (2) they don't get enough light and have a tendency to elongate or stretch, and (3) plants may become attached to the cover and may be pulled from the trays as the covers are removed. The plant level covers should be removed as soon as the plants are big enough to protect the cell from damage (about dime size). There are also some commercial materials available that can be sprayed on interior surfaces of greenhouses reducing surface tension to help water roll off the sides rather than drip. Some growers with outside beds have taped vinyl corner molding to the undersides of their bows to help channel condensation away from the trays.

Circulation Fans

Circulation fans are primarily designed for one purpose, to circulate heat and air. This prevents the formation of hot and cold zones which could influence plant growth in those areas. Circulations fans should be located approximately 40-50 feet apart and one-fourth of the house width from each sidewall and halfway between plant level and the roof. A slight downward angle will improve air circulation near the plant. Fans pointed down too severely can increase evaporation on the tray surface and may potentially increase salt accumulation at the soil surface affecting germination and plant growth. An elliptical pattern across several trays and in front of a fan is generally an indication that a circulation fan is positioned at too steep of an angle.

Clipping

Proper clipping of float plants helps to toughen the plants, promotes uniformity, increases stem diameter, and aids in disease control. When done properly, clipping does not slow the growth of plants, nor does it contribute to early blooming or ground sucker formation.

The first clipping is usually the most beneficial and direct seeded float plants should be clipped the first time when the plant buds are approximately 1.5–2 inches above the tray surface. Plants will start to leave the tray growing away from the tray surface. The first clipping should remove approximately ½–1 inch of leaf material. The first clipping promotes uniformity, particularly in outside direct seeded beds where germination is often uneven. Smaller plants may not be clipped the first time, but will benefit from more sunlight and less competition from plants that were taller prior to clipping. After the first clipping, plants should be clipped every 5–7 days depending on growth rate. At each clipping, remove no more than ½–1 inch of leaf material. Three to five clippings may be necessary to achieve the best plant quality. Seldom are more than five clippings necessary. However, plants produced in trays with smaller cells (338) may require more clipping. Plants that need to be held for some length of time prior to transplanting can be clipped an additional time to help manage plant size and slow plant growth. Hard clipping (removing more than 1 inch of leaf material) should be avoided unless plant growth needs to be controlled. Plants should never be clipped so severely that buds are damaged. Transplants with buds removed may yield much less than non-injured plants.

Plugged plants should be clipped for the first time approximately 1–2 weeks after plugging (as soon as the roots have established). The same guidelines apply to clipping plugs as apply to direct seeded plants. Plugged plants should only require two or three clippings, unless setting is delayed.

When clipping plants, sanitation of the clipping equipment must be done to avoid spreading diseases. When done properly, clipping actually aids in disease control by opening up the plant canopy to allow for greater light penetration and improved air circulation around the plants. The mower and surrounding frame should be thoroughly cleaned after each use and sprayed with a disinfecting solution of 10% bleach or a commercial greenhouse disinfectant. If left on metal surfaces, bleach will promote rust, so rinse all surfaces after 10 minutes of contact time.

The key to effective clipping of float plants is to make a clean cut and remove the clipped material from the area. To accomplish this use a sharp blade and adjust the mowers speed so that the clipped material is lifted off the plants and deposited in the bagger. A high blade speed will result in the material being ground to a pulp and being deposited back on the trays, thereby increasing the likelihood for diseases. A dull blade may tear the leaf which may not promote proper healing. A relatively low blade speed with a sharp blade works best. Although some vacuum is necessary to push clipped leaves into a leaf catcher, a high vacuum may pull plants from the trays or suck the trays up into the blade. Dispose of clippings in an area well away from the greenhouse to prevent disease development that could spread to healthy plants in the float bed. Gasoline powered reel type mowers have been used successfully for clipping plants, since this type of mower tends to make a clean cut producing large pieces of intact leaf and deposits them in a catcher with little or no grinding. However, rotary mowers may be easier to adjust and maintain. An improperly maintained or adjusted mower may result in improper clipping that could injury plants, reduce vigor and promote disease development.

Pest Control in Tobacco Float Beds

EPA has ruled that outside float beds are considered as mini-greenhouses for the purposes of chemical pest control options. This means that only chemicals labeled for use on tobacco in greenhouses can be used on outside float beds. Chemicals that are labeled have specific instructions concerning the contamination of float water. This limits the chemical options available for controlling diseases and insects in these systems.

The first line of defense in controlling pests is exclusion of the pest. A good sanitation program will not eliminate pests from the system, but it will reduce their numbers and reduce the likelihood that they will cause economic loss. In addition to disinfection of trays, a good sanitation program includes removing weeds from around the bed area, and the cleaning of equipment used in and around the beds. Locate the float site away from tobacco fields, barns, and stripping rooms to reduce the chance of carrying disease over from one crop year to the next.

Management of Insect Pests

A variety of insects and other organisms that live naturally in water or moist organic matter can cause problems in the float system. Moist media, algae and organisms that can grow float water provide ideal conditions and food for fungus gnats and shore flies. Pillbugs, and even dung beetles, can burrow into media while slugs and cutworms feed on developing plants. While some are harmless, others eat or uproot seedlings and can destroy many plants before they are noticed.

Flies and Gnats

Fungus Gnats. Occasionally, fungus gnat larvae can be serious pests in greenhouses. The legless white larvae with distinct black heads are scavengers that live in and feed on decaying organic matter. Occasionally, they will feed on root hairs, enter the roots, or even attack the stem or crown of the plant. Infested plants generally lack vigor and may begin to wilt.

Fungus gnats are small (1/8 inch) black flies with long legs and antennae, tiny heads, and one pair of clear wings. Females lay tiny ribbons of tiny yellowish white eggs in the growing media that hatch in about 4 days. The larvae feed for about 14 days and then pupate in drier surface media. Adults live about a week. Under greenhouse conditions, they can complete a generation in 3–4 weeks.

Shore Flies. Shore flies also are small gnats but have short antennae, heavier, darker bodies and a pair of smoky wings with several distinct clear spots. They are good fliers and can be seen resting on most any surface. The life cycle is similar to that of the fungus gnat. The yellow to brown larvae are up to 1/4 inch long and have no apparent head. Both larvae and adults feed mostly on algae growing on media, or other surfaces. Sometimes they will bore directly into the bases of small plants. Plants damaged by them will break easily at the soil surface. The adults may spread soil pathogens inside the greenhouse.

Bloodworms. Bloodworms are the striking red worms that live free in float water with lots of algae growth; they do not live in the media. The red color comes from hemoglobin, the same oxygen-carrying material present in our blood. Hemoglobin allows this insect to develop in still, stagnant water. These gnat larvae have chewing mouthparts and generally feed on algae or other organic matter in the water. They may be found in plant roots that grow through the bottoms of float trays but do not feed on them.

These insects are close relatives of the mosquito but the adults (gnats) do not have sucking mouthparts and are not blood feeders.

Reducing Fly/Gnat Problems

Eliminate standing puddles around the area and provide good drainage around the greenhouse or float beds. Have a minimum amount of exposed water surface in the float bed, float empty trays to fill the bed so open water is not available. This is where mosquitoes and many gnats lay their eggs.

Regularly clip grass along bed margins so these areas can dry quickly.

Excessively wet potting mixtures in trays are attractive to egg laying fungus gnats. Algal growth on the surface will attract shore flies. Keep moisture content optimum for plant growth but not above that level.

Yellow sticky cards (available from greenhouse supply stores) can be tacked to pot stakes or suspended in the area to monitor for buildup of gnats. An early insecticide treatment will be more effective than one applied when fly numbers are very high.

Foliar sprays of acephate (Orthene, etc.) can be used to reduce numbers of adults to some extent but do not get to larvae in the media so new adults will continue to be produced.

Slugs

Slugs can cause serious damage to float plants. They are active very early in the spring and can chew up small plants as they just begin to grow. Slugs can enter from overgrown areas around the bed or may come from under plastic bed liners. Slugs feed at night or during overcast days and hide in cool, moist places during sunny days. They rasp leaves and tender stems, producing holes or scars on the leaf surface. They leave behind silvery slime trails as they move.

Reducing Slug Problems. Sanitation is very important for slug control. Keep the area around float beds free of plant debris (leaves, pulled weeds, etc.), old boards, bricks, or stones that provide cool moist hiding places for slugs. Frequent clipping of plants along the outside margin of the beds will let the area dry out so it is less attractive to slugs. Metaldehyde bait pellets can be distributed along these areas, too. It is best manage slugs before they get to the trays. Insecticides are not effective against slugs.

Cutworms

The variegated cutworm has caused serious problems in a low percentage of float systems most every year. The adult (a moth) flies in mid-March and lay clusters of about 60 eggs on the stems or leaves of low-growing plants. The smooth pale gray to light brown larvae have a row of pale spots down the center of their backs. They feed for about 3-1/2 weeks and are about 1.6 inches long when full grown. Since they occur in clusters, entire trays of plants can be chewed up in a short time. The cutworms hide during the day in tray media and feed at night. When monitoring for these insects look for cut plants or leaves with large sections removed.

Infestations often begin in trays along outer walls and spread in a circular pattern from there. Feeding by small cutworms appears as notches along leaf margins and is easy to overlook. Feeding rate increases dramatically as the larvae grow, so extensive damage can seem to appear overnight. In fact, the cutworms are there usually for about 2 weeks before they eat enough to be noticed.

Reducing Cutworm Problems. Keep outside bed margins trimmed so plant growth is not attractive to moths.

- Keep doors closed or screened at night when moths are flying.
- Check trays along bed margins regularly for feeding damage to leaves. This is a good way to detect problems early.
- Foliar sprays of acephate (Orthene, etc.) or sprays of Bt insecticides (Dipel, etc.) will kill cutworms.

Pillbugs

Pillbugs are scavengers that feed mainly on decaying organic matter. They occasionally feed lightly on young plants but the damage seldom is significant. They do churn up and burrow into plant media, uprooting and killing small seedlings. Once in trays, it is difficult to control them. Their armored body protects them from insecticide spray droplets.

Pillbugs can only survive in humid air so they hide under objects during the day. They are common under plastic, boards, stones, other items resting on damp ground. They will congregate in grassy or overgrown areas, too.

Clean-up and regular mowing along the outside of bed structures will remove hiding places and allow areas to dry. Old plastic liners provide cover for pillbugs and should be removed. Pillbugs will leave for better conditions.

Leave a few small pieces of plywood on the ground and check under them regularly for accumulations of pillbugs or slugs. If many are found, the area can be sprayed with an insecticide before they enter trays.

Tobacco Aphids/Green Peach Aphids

Tobacco aphids or green peach aphids can begin to build up when covers are removed or sides are opened to let plants begin to harden off before transplant. Infestations start as winged aphids settle on plants and begin to deposit small numbers of live young. The initial infestation consists of a few aphids on scattered plants but these insects are fast reproducers and numbers can increase rapidly.

Since aphids are sap feeders, there are no holes in the leaves or distinct symptoms to attract attention. Begin checking random trays for aphids about 7–10 days after plants are uncovered and continue to check a few trays each week until transplant time. Look in the undersides of leaves for colonies.

Acephate (Orthene, etc.) can be used for aphid control in greenhouses and outdoor float systems. Catch infestations before they become too large to control effectively and direct sprays to the undersides of the leaves.

Thrips

Thrips are slender, tiny (1/25") long light brown to black insects. They feed by rasping the plant leaf surface and sucking up the exuding sap. Heavily infested leaves have a speckled or silvery appearance. Thrips feeding can damage the growing point and cause stunted, unthrifty plants, but they also can carry tomato spotted wilt / impatiens necrotic spot virus.

Thrips infestations are rare in outdoor float systems but could be a significant problem in greenhouse systems where at least some plants are kept year-round. They can be carried into the greenhouse on contaminated plant material or fly in during the summer and continue to breed throughout the winter.

Blue sticky cards, available from greenhouse suppliers, can be used to monitor thrips and to assess control efforts. Control of established infestations is difficult and usually requires several insecticidal sprays at regular intervals.

Prevention of infestations through the use of screens on ventilators, inspection of new material entering the greenhouse, and weed control in the greenhouse will help to manage thrips.

Cultural Controls are Essential

Cultural controls are the primary defense against pest infestations. Good practices include:

- Keep doors, screens and ventilators in good repair.
- Use clean or sterile media.
- Clean soil from tools, flats and other equipment.
- Maintain a clean, closely mowed area around the greenhouse or float beds.
- Eliminate pools of standing water on floors. Algal and moss growth in these areas can be sources of fungus gnat and shore fly problems.
- Dispose of trash, boards and old plant debris in the area.
- Remove all plants and any plant debris, clean the greenhouse thoroughly after each production cycle.
- If possible, allow greenhouse to freeze in winter to eliminate tender insects like whiteflies.
- Avoid over watering and promote good ventilation to minimize wet areas conducive to fly breeding.

Management of Diseases

General Information

The introduction of the float system revolutionized the way we produce tobacco transplants in Kentucky and other tobacco-growing areas around the United States. The float system offers a number of advantages over the traditional plant bed but also creates ideal conditions for some important diseases of tobacco transplants. High moisture in this virtually hydroponic system favors infection of roots and leaves by a number of plant pathogens, as does the dense plant population.

Prevention is the most important part of disease management in tobacco float beds, or any other production system for that matter. We put more emphasis on prevention in the float system, though, because of the disease-conducive environment and the relative lack of fungicide tools that we can use to prevent disease or slow disease spread once it begins.

The major diseases encountered in production of transplants in the float system are Pythium root rot, target spot, Sclerotinia collar rot, blue mold and black leg. Less common are anthracnose, damping-off (Pythium and Rhizoctonia), Botrytis gray mold, angular leaf spot, and virus diseases (such as tobacco mosaic). As mentioned earlier, careful management of the environment and good sanitation are key considerations. The following is a summary of recommended practices for control of diseases commonly encountered in the float system. Tables of recommended fungicides (Table 5) and relative effectiveness of cultural chemical practices against common diseases (Table 6) have been included at the end of this section.

Exclude Pathogens from Transplant Facilities

Avoid the introduction of plant pathogens into the float system. Water from ponds or creeks can harbor fungi like Pythium or the black shank pathogen that can wreak havoc in the float system. Keep soil out of float bays—this can also cause pathogens such as Pythium to be introduced into the system. Keep trays out of contact with soil as well. Control weeds in and around the greenhouse or outdoor bed, since these can harbor a number of plant pathogens that can move, on the air or by insects, onto tobacco seedlings. If purchasing plugs (plug-and-transfer system), consider plants from a local or northern source. Southern-produced plugs are at risk for exposure to the blue mold pathogen in areas where they are grown, and have been linked to serious outbreaks of blue mold in previous seasons (2006, for example). These same considerations are valid if you are buying finished plants to set in the field. Do not grow transplants near vegetable fields, and do not grow ornamentals or vegetables in the same facilities where tobacco seedlings are being produced. Ornamentals and vegetables can harbor pathogens that can attack tobacco.

Make Sanitation a Routine Practice

Sanitize old trays as recommended, or use new trays. New trays will all but eliminate carrying diseases over between crops of transplants. New trays will not harbor plant pathogens, but re-used trays pose more of a risk and this risk increases as trays age. There is no guaranteed, foolproof way to sanitize used trays; however, we do have methods that will significantly reduce survival of plant pathogens on trays. Refer to the section on tray sanitation for more information. Dispose of unused or diseased plants promptly and properly. Bury or burn plants, or place them in cull piles located at least 100 yards from float beds or tobacco fields. This is especially important in the management of Sclerotinia collar rot. Remove clippings and debris to prevent buildup of material that can favor development of collar rot or black leg (bacterial soft rot). Don't mow plants if diseases such as black leg are active, as this will spread disease from infected to healthy seedlings. If blue mold is found in float beds, destroy all plants immediately, even if only a small number actually show symptoms of disease. Plants with no symptoms in float beds where sporulating plants are found are likely infected with the blue mold pathogen but have yet to develop symptoms. Given time, disease will develop on these plants as well. Sanitize equipment (mowers, for example), tools, and other items (shoes, hands) that will come into contact with plants or float water. Use a 10% bleach solution for equipment and shoes, and antimicrobial soap for hands to prevent the introduction of pathogens.

Create an Unfavorable Environment for Plant Pathogens

Maintain good air movement through the use of side vents and fans, and keep water levels high enough for float trays to clear the side boards of the bays, which allows for better movement of air (water level may be kept low initially when plants are small to prevent cold injury and raised as plants grow). Long periods of leaf wetness favor most diseases encountered in the float system. Good airflow promotes rapid drying of foliage, creating less favorable conditions for diseases such as target spot, collar rot, blue mold, and black leg. Minimize the potential for water to splash between trays. Avoid overhead irrigation, fix leaks in roofs, and apply fungicides early in the day so that foliage dries quickly. Temperature control is critical as well—excess heat can lead to problems with target spot and black leg, while cooler temperatures favor collar rot and blue mold. Don't over-pack media into cells when seeding, as this leads to excessively wet conditions in the tray, favoring the development of disease. Older trays tend to water-log easily, causing media to become saturated. Trays with high cell counts (338) not only require more management, but the dense foliage may favor disease development.

Minimize Plant Stress

Keep your transplants as stress-free as possible. Avoid temperature extremes and keep fertilizer levels within recommended ranges. Plants that are under- or over-fertilized are more susceptible to diseases in general. For example, target spot is much more likely to develop if nitrogen levels are below 50 ppm for extended periods of time, while black leg is generally seen when nitrogen is consistently above 150 ppm. Excess nitrogen also leads to rapid, rank growth of transplants. New, succulent growth is more disease-prone, and also takes longer to dry out. When clipping plants, avoid the buildup of leaf matter on float trays. Some pathogens, particularly Sclerotinia and bacteria that cause soft rots and black leg, can use leaf debris as a food base to become established and then spread in the float system. Clip properly (see section on clipping) to minimize stress and also the volume of clippings, and use a well-sharpened blade to promote rapid healing of wounds. Make sure that plants dry quickly after mowing.

Table 5. Guide to chemicals available for control of tobacco diseases 2008—transplant production.

	Product Rate Per			
Product(s)	**Application[a]**	**Season**	**Target Diseases**	**Label Notes**
Agricultural Streptomycin	100-200 ppm	no limit	wildfire	Apply in 3-5 gal/1000 sq. ft.
Agri-Mycin 17	1-2 tsp/gal H_2O		blue mold	
Aliette WDG	0.5 lb/50 gal H_2O	1.2 lb per 1000 sq. ft.	blue mold	Apply 3 gal of solution per 1000 sq. ft. on small plants; increase to a maximum of 12 gal as plants grow.
Dithane DF	0.5 lb/100 gal H_2O	no limit	blue mold anthracnose damping-off	Apply 3-12 gal/1000 sq. ft. as a fine spray. Begin when plants are dime-sized or larger.
Milk: Whole/Skim	5 gal/100 gal H_2O	no limit	tobacco mosaic virus (plant-to-plant spread)	Apply to plants at least 24 h prior to handling. Mix will treat 100 sq. yd.
Milk: Dry	5 lb/100 gal H_2O			
Terramaster 4 EC	1.0-1.4 fl oz/100 gal H_2O	2.8 fl oz	damping-off (Pythium spp.) root rot (Pythium spp.)	Apply to float-bed water no earlier than 2 weeks after seeding. Additional applications can be made at 3-week intervals. Use high rate for curative treatments; begin no sooner than 3 weeks after seeding. Do not apply later than 8 weeks after seeding.

[a] *Rate range of product. In general, use higher rates when disease pressure is high. Refer to product label for application information, restrictions, and warnings.*

Table 6. Relative effectiveness of recommended practices for management of diseases of tobacco transplants.

Recommended Practice	Pythium Root Rot	Pythium Damping-off	Target Spot (Rhizoctonia)	Rhizoctonia Damping-off/Soreshin	Collar Rot (Sclerotinia)	Blue Mold	Black Leg/ Bacterial Soft Rot	Anthracnose	Botrytis Gray Mold	Angular Leaf Spot	Virus Diseases	Algae
Use new/sterilized trays	+++[a]	+++	+++	+++	+	-	-	+	-	-	-	+++
Use municipal water to fill bays	++	++	+	+	-	-	+	-	-	-	-	++
Sanitize equipment, shoes, hands, etc.	++	++	+	+	-	-	++	+	+	-	+++	-
Avoid contact of trays with soil	+++	+++	++	++	-	-	+	+	+	-	-	+
Maintain air movement	-	+	+++	+	+++	+++	+++	+++	+++	+++	-	-
Fungicides[b]	+++	+++	++	++	-	++	+	++	+	+	-	+
Maintain proper fertility[c]	+	++	+++	+	++	+	+++	+	+	+	-	+++
Temperature control	+	+	++	+	+	+	++	++	+	+	-	+
Minimize splashing	-	+	++	+	-	-	++	+++	+	++	-	-
Proper clipping[d]	-	-	++	+	++	+	++	++	+	+	-	-
Avoid buildup of leaf clippings in trays	-	+	+	++	++	-	++	+	++	-	-	-
Dispose of diseased plants properly	-	-	+	+	++	++	++	+	+	+	-	-
Weed control in/around float system	-	-	+	+	+	-	++	++	+	++	++	-
Insect control	-	-	-	-	-	-	+	+	+	-	++	+
Avoid out-of-state transplants	-	-	-	-	-	+++	-	-	-	-	+	-
Avoid tobacco use when handling plants	-	-	-	-	-	-	-	-	-	-	++	-

[a] *- = no effect on disease management, + = minimally effective, ++ = moderately effective, +++ = highly effective.*
[b] *Preventive applications only (made before symptoms appear).*
[c] *Based upon a recommended range of 75-100 ppm of nitrogen.*
[d] *Clip using a well-sharpened blade under conditions that promote rapid drying of foliage.*

Apply Fungicides Wisely

Relatively few fungicide products are labeled for use on tobacco in the float system, and only Pythium root, blue mold, and target spot/damping-off are targeted by these products. The remaining diseases can be managed only by cultural practices.

Fungicides can be effective in a disease management program, but applications must be made in a timely way for best results. For example, it is possible to get good-to-excellent control of Pythium root rot (PRR) with Terramaster 4EC, but only if the material is applied preventively. Make the first application 2-3 weeks after seeding, or when roots first enter the water. A second treatment can be made 3 weeks after the first, and a final application (if needed) can be made two weeks after the second treatment. Do not apply Terramaster later than 8 weeks after seeding; make sure that the product is mixed thoroughly in float bays to minimize the risk of phytotoxicity. "Rescue" applications of Terramaster (see Table 5 for rates) in systems with active PRR will halt further development of disease and symptomatic seedlings will likely recover. However, the higher rates of Terramaster used in rescue treatments increase the risk of phytotoxicity AND recuperating plants may still harbor Pythium that can weaken them and neighboring plants later in the season (and increase their susceptibility to black shank and Fusarium wilt). Terramaster will burn the roots of tobacco seedlings, but plants quickly recover. Stress from root burn is minimized if Terramaster is applied when roots first enter the float water, and is greatest if the fungicide is applied to seedlings with extensive root systems. Severe root burn can lead to stunting and delayed development of seedlings—reason enough to begin applications of Terramaster early.

Dithane DF is a widely used fungicide that is labeled for target spot, damping-off (Rhizoctonia), and blue mold. Dithane DF provides reasonable control of target spot and because it is a protectant-type fungicide (not systemic, and has no curative activity), it should be applied at the first signs of disease at the latest (see Table 5 for rates). Use 3 gal of spray material per 1000 sq. ft., applied as a fine spray to improve coverage, while plants are small, and increase gradually to 6 to 12 gal as plants grow to transplantable size. Be sure sufficient water is used to wet the base of the stems with runoff to increase the control potential of damping off. Avoid contamination of the floatwater during treatment. Do not apply this fungicide to plants smaller than dime-size to avoid damage. Producers with a history of problems with target spot should consider routine application of Dithane DF, beginning when plants are dime-sized and continuing on a 5-10 day schedule, depending upon age of transplants and weather conditions. For control of blue mold, Dithane DF must be in place before plants become infected. Because of the fast-moving, explosive nature of blue mold in the float system, applications made after the first signs of disease have little chance slowing the disease down to manageable levels. Refer to Cooperative Extension office, local press and radio, and UK extension specialists for guidance on when to treat for blue mold. You can also visit the Kentucky Tobacco Disease Information page (http://www.uky.edu/Ag/kpn/kyblue/kyblue.htm) for up-to-the minute reports on blue mold and other diseases. Apply Dithane DF more frequently to rapidly growing plants, if conditions are warm, humid and overcast, or if target spot is present.

Other products that can be used in the float system include Aliette WDG (blue mold), agricultural streptomycin (blue mold, angular leaf spot/wildfire), and milk (tobacco mosaic virus). Apply Aliette or streptomycin to plants dime-sized or larger in a manner similar to Dithane DF (see Table 5 for rates). Do not allow either Aliette or streptomycin to contaminate float water, as serious injury to plants can occur. Keep in mind, too, that products that specifically prohibit use in greenhouses cannot be applied to tobacco in the float system, since the EPA considers float beds to be mini-greenhouses. Only products labeled for tobacco can be used—do not apply products intended for greenhouse ornamentals or bedding plants to tobacco. Producers can use existing stocks of materials that are no longer labeled for tobacco (Ferbam Granuflo, Carbamate, Terramaster 35WP) so long as a copy of the original product label is possessed by the grower. Follow all label directions and take special care to protect workers from exposure to pesticides.

Develop an Integrated Plan to Manage Diseases

Disease-free transplants pay dividends down the road because they are more vigorous and less prone to attack by pathogens in the field. Use a management strategy that integrates management of the environment, sanitation, and fungicides to get the best possible control of diseases in the float system and produce the best transplants that you can. While it may not be possible to avoid diseases completely, integrated management practices will reduce the impact of diseases in the float system greatly.

Special Considerations for Outside Direct Seeded Float Beds

Production of tobacco transplants in outside direct seeded beds is inherently more risky than greenhouse production or plug and transfer. Though the cost of transplants is lower in direct seeded outside beds the chances of plant loss are greater. Although results are related to the uncertainty of the weather, the risk of plant loss can be reduced by good preparation and management.

Construction of an outside float bed doesn't have to be complicated. However, a few details can make construction easier. A level spot is essential because water will find the level. Having a deep end and a shallow end can result in fertilizers settling to the low end and, as water evaporates, trays may be stranded without water on the shallow end.

The float bed area must be free of debris that could potentially punch a hole in the plastic liner. Sand spread evenly within the bed area provides a good foundation.

Bed framing made from 2 x 6's or 2 X 8's is sufficient to construct a float bed. Most float trays are slightly smaller than 14" x 27". However, using these measurements to calculate the dimensions should provide the extra room need to assure a good fit, but to ensure that the fit is not too tight.

Six mil plastic is more forgiving and preferred over thinner plastic. The plastic should be draped over the framing and pushed into corners prior to filling with water. The addition of water to the bed will complete the forming of the plastic to the sides and only then should the plastic be tacked to the frames. Stapling through plastic strapping materials makes a more secure attachment of the plastic lining to the frames. The bed should be no wider than can be covered by a conventional cover stretched over bows. Bows should be 2–4 feet apart and can be constructed of metal or PVC pipe, but need to be strong enough to support the wet weight of the cover. Bows spaced wider apart will need to be stronger than those spaced closer together. Allowing some head space over the plant aids ventilation.

Covering materials are most commonly made from either spun-bonded polypropylene (Reemay covers) or spun-bonded Polyethylene (Continental covers). Both provide some protection from the cold and rain. However, temperatures can fall below the outside temperature inside the beds during the night. The most plausible explanation is that evaporative cooling inside the bed is responsible for the drop in temperature. Outside beds may not be suitable much earlier than the middle of April unless supplemental heat is used. Heat can be obtained from 150-watt light bulbs placed at each bow or every other bow depending on the degree of heat need anticipated. If any electrical appliances or equipment are used near the float bed, a ground fault interrupt (GFI) should be installed at the outlet or in line.

Plastic covers can help reduce rain damage to freshly seeded trays and trays where plants have not cover the cell. However, failure to remove the plastic when the sun comes out can damage seeds and kill plants very quickly. While a clear cover heats up inside quicker, a black plastic left on for an extended period of time during rainy weather can cause plants to stretch. Once plants stretch they will not recover.

Plugged plants and greenhouse grown plants are more susceptible to rapid changes in temperature and should have at least two days to acclimate in an outside bed prior to a cold snap. Newly plugged plants are also susceptible to wind damage which can desiccate plants. Normal plant bed covers are usually sufficient to protect plants. Once new roots become established (two days are usually sufficient), wind is less of a problem.